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FINAL OPERATION AND MAINTENANCE MANUAL FOR GROUNDWATER RECOVERY AND TREATMENT SYSTEM VOLUME 2 OF 2 NAS FORT WORTH TX
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ADMINISTRATIVE RECORD COVER SHEET

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HYDRO GeoLogic INC.

FINAL OPERATION AND MAINTENANCE MANUAL FOR THE GROUNDWATER RECOVERY AND TREATMENT SYSTEM NAS FORT WORTH JRB, TEXAS

VOLUME II OF II

AI CENTER FOR ENVIRONMENTAL EXCELLENCE

Prepared for

U.S. Air Force Center for Environmental Excellence
Brooks Air Force Base, Texas

Contract Number F41624-95-D-8005

February 2000

HydroGeoLogic, Inc
1155 Herndon Parkway
Suite 900
Herndon, Virginia 20170
(703) 478-5186

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TAB

Appendix 7

APPENDIX F
MANUFACTURERS' EQUIPMENT MANUALS

GROUNDWATER RECOVERY SYSTEM

- **Submersible Pump**
- **Flow Monitor/Totalizer**
- **Flow Sensor**
- **Level Controller**
- **Turbine Flow Meter**

Technical Data 25GPM Model 25S

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES A	B	C	D	E	APPROX. SHIP WT.
25S05-3	A	1/2	4"	1 1/2" NPT	18.1	9.5	8.6	3.8	3.9	26
25S07-5	A	3/4	4"	1 1/2" NPT	20.9	10.7	10.2	3.8	3.9	28
25S10-7	A	1	4"	1 1/2" NPT	23.7	11.8	11.9	3.8	3.9	29
25S15-9	A	1 1/2	4"	1 1/2" NPT	27.1	13.6	13.5	3.8	3.9	34
25S20-11	A	2	4"	1 1/2" NPT	30.3	15.1	15.2	3.8	3.9	37
25S30-15	A	3	4"	1 1/2" NPT	39.1	20.6	18.5	3.8	3.9	59
25S50-26	A	5	4"	1 1/2" NPT	51.2	23.6	27.6	3.8	3.9	76
25S75-39DS*	A	7 1/2	6"	1 1/2" NPT	66.8	24.2	42.6	5.4	4.6	168
25S100-52DS*	B	10	6"	1 1/2" MPT	90.9	25.4	65.5	5.4	5.4	226

NOTES All models suitable for use in 4" wells, unless otherwise noted
Weights include pump end with motor in lbs
* Built into sleeve 1½" MPT discharge, 6" min well dia

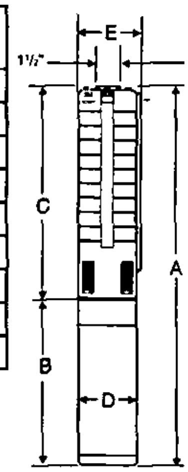


Fig. A

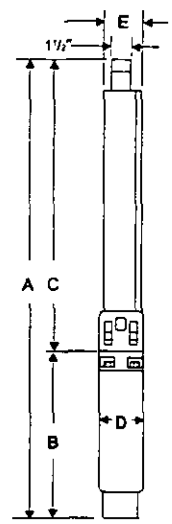


Fig. B

MATERIALS OF CONSTRUCTION

COMPONENT	SPLINED SHAFT (3-26 Stgs.)	CYLINDRICAL SHAFT (39 Stgs.)	DEEP SET (52 Stgs)
Check Valve Housing	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Check Valve	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Impeller	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Suction Interconnector	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Inlet Screen	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Pump Shaft	304 Stainless Steel	431 Stainless Steel	431 Stainless Steel
Straps	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Cable Guard	304 Stainless Steel	304 Stainless Steel	304 Stainless Steel
Priming Inducer	304 Stainless Steel	316 Stainless Steel	316 Stainless Steel
Coupling	329/420/431 Stainless Steel	329/420/431 Stainless Steel	329/416 Stainless Steel**
Check Valve Seat	NBR/304 Stainless Steel	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Top Bearing	NBR/304 Stainless Steel	NBR/316 Stainless Steel	NBR/316 Stainless Steel
Impeller Seal Ring	NBR/PBT (Valox®)	NBR/PPS (Ryton®)	NBR/PPS (Ryton®)
Intermediate Bearings	NBR	304 Stainless Steel	NBR/316 Stainless Steel
Shaft Washer	Not Required	LCP (Vectra®)	LCP (Vectra®)
Split Cone	Not Required	304 Stainless Steel	304 Stainless Steel
Split Cone Nut	Not Required	316 Stainless Steel	304 Stainless Steel
Sleeve	Not Required	Not Required	316 Stainless Steel
Sleeve Flange	Not Required	Not Required	Zincless Bronze*
Coupling Key	Not Required	Not Required	302/304 Stainless Steel**

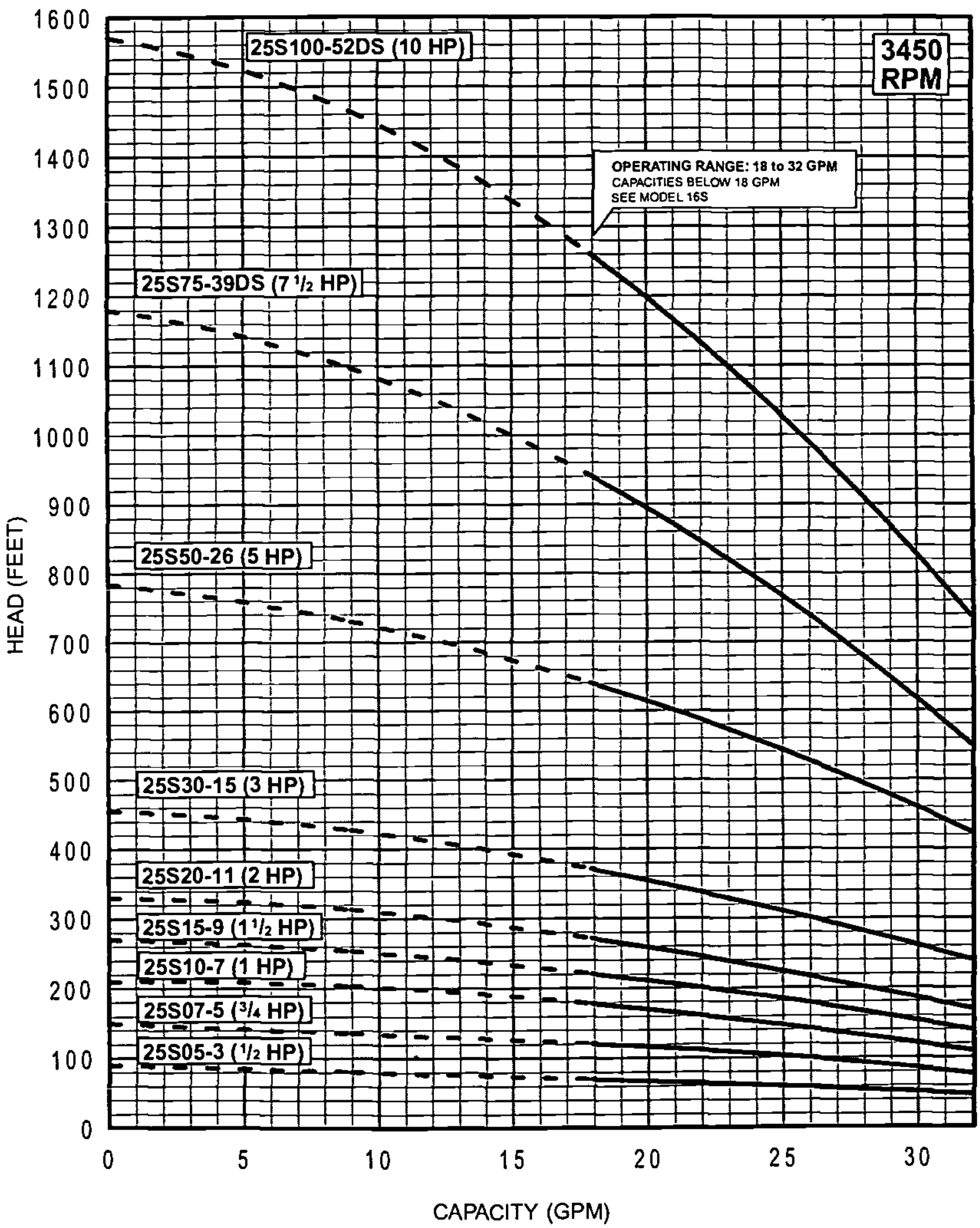
NOTES Specifications are subject to change without notice
Valox ® is a registered trademark of General Electric Co
Vectra ® is a registered trademark of Hoechast Calanese Corporation.
Ryton ® is a registered trademark of Phillips 66
***Stainless Steel option available.**
** If using 4" non-standard motors, refer to 329/420/431 Stainless Steel for coupling
A coupling key is not required

GRUNDFOS
GRUNDFOS PUMPS CORPORATION • 2555 Clovis Avenue • Clovis, CA • 93612
Area Centers: Allentown, PA • Atlanta, GA • Chicago, IL • Clovis, CA • Dallas, TX • Seattle, WA
(800) 333-1366 • FAX (800) 333-1363
Canada Mississauga, Ontario • **Mexico:** Apodaca, N L

LSP-TL-1025 6/96
PRINTED IN USA

Model 25S 25 GPM Performance Curves

FLOW RANGE: 18 -32 GPM **OUTLET SIZE: 1½ " NPT** **NOMINAL DIA. 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 5-5 HP/3450 RPM
6" MOTOR STANDARD,7 5-10HP/3450 RPM

Performance conforms to ISO 2548 Annex B
@ 2 ft min submergence

GRUNDFOS

LIMITED WARRANTY

Products manufactured by GRUNDFOS are warranted to the original user only to be free of defects in material and workmanship for a period of 18 months from date of installation, but not more than 24 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS factory or authorized service station, any product of GRUNDFOS manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid, documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

MANUFACTURER WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE. EXCEPT AS EXPRESSLY HEREIN PROVIDED THE GOODS ARE SOLD "AS IS", THE ENTIRE RISK AS TO QUALITY AND FITNESS FOR A PARTICULAR PURPOSE, AND PERFORMANCE OF THE GOODS IS WITH THE BUYER, AND SHOULD THE GOODS PROVE DEFECTIVE FOLLOWING THEIR PURCHASE, THE BUYER AND NOT THE MANUFACTURER, DISTRIBUTOR, OR RETAILER ASSUMES THE ENTIRE RISK OF ALL NECESSARY SERVICING OR REPAIR.

Some jurisdictions do not allow the exclusion or limitation of implied warranties of merchantability and fitness for a particular purpose, of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.
The telephone number of our service and repair facilities central directory, from which you can obtain the locations of our service and repair facilities is, 1-800-333-1366

GRUNDFOS®

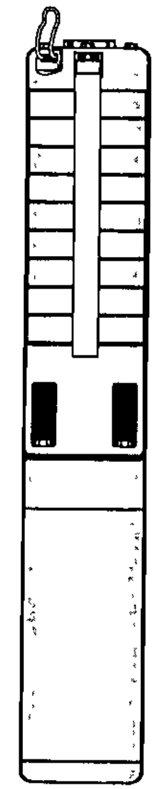
Leaders in Pump Technology

Grundfos Pumps Corporation • 3131 N. Business Park Ave., Fresno, CA 93727
Customer Service Centers: Allentown, PA • Fresno, CA
Phone: (800) 333-1366 • **Fax:** (800) 333-1363
Canada: Oakville, Ontario • **Mexico:** Apodaca, N.L.
Visit our website at www.us.grundfos.com

L-SP-TL-048 | Rev 5/96
PRINTED IN USA

SP4"

Installation and Operating Instructions



4-Inch Stainless Steel Submersible Pumps

Please leave these instructions with the pump for future reference

685 8

GRUNDFOS®

Leaders in Pump Technology

SAFETY WARNING

Electrical Work

WARNING: Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor (at least the size of the circuit supplying the pump) to the grounding screw provided within the wiring compartment.

Pre-Installation Checklist

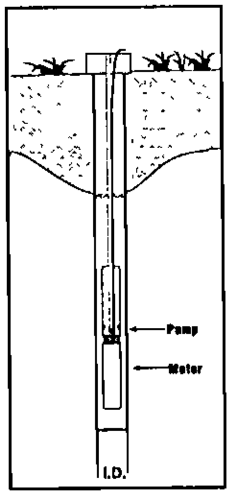
1. Well Preparation

If the pump is to be installed in a new well then the well should be fully developed and bailed or blown free of cuttings and sand. The stainless steel construction of the GRUNDFOS submersibles makes it resistant to abrasion; however, no pump made of any material can forever withstand the destructive wear that occurs when constantly pumping sandy water

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine in an existing well, the well must be blown or bailed clear of oil

2. Make Sure You Have the Right Pump

Determine the maximum depth of the well, and the drawdown level at the pump's maximum capacity Pump selection and setting depth should be made based on this data.



3. Pumped Fluid Requirements

Submersible well pumps are designed for pumping clear, cold water; free of air or gases. Decreased pump performance and life expectancy can occur if the water is not clear, cold or contains air or gases. Water temperature should not exceed 102°F

A check should be made to ensure that the installation depth of the pump will always be at least three feet below the maximum drawdown level of the well. The bottom of the motor should never be installed lower than the top the screen or within five feet of the well bottom

Ensure that the requirement for minimum flow past the motor is met, as shown in the table below

Minimum Water Flow Requirements for Franklin 4-Inch Submersible Pump Motors

Minimum Diameter	Casing or Sleeve I D in Inches	Min. GPM Flow Passing the Motor
4-Inch	4	1 2
	5	7
	6	13
	7	21
	8	30

NOTES:
a For Franklin Motors Only A flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor
b For Franklin Motors Only The minimum water velocity over 4" motors is 0 25feet per second
c Grundfos 4" submersible motors do not require a minimum flow or flow sleeve

Pre-Installation Checklist

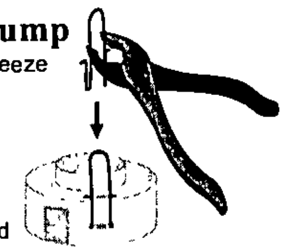
4. Splicing the Motor Cable

If the splice is carefully made, it will be as efficient as any other portion of the cable, and will be completely watertight There are a number of cable splicing kits available today - epoxy filled, rubber-sealed and so on Many perform well if the manufacturer's directions are followed carefully If one of these kits is not used, we recommend the following method for splicing the motor cable.

Examine the motor cable and drop cable carefully for damage. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads Be sure to match the colors. Strip back and trim off one-half inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation Insert a properly sized Sta-Kon-type connector on each pair of leads, again making sure that colors are matched Using Sta-Kon crimping pliers, indent the lugs. Be sure to squeeze down hard on the pliers, particularly when using large cable. Form a piece of electrical insulation putty tightly around each Sta-Kon. The putty should overlap on the insulation of the wire Use a good quality tape such as ***#33 Scotch Waterproof or Plymouth Rubber Company Slipknot Grey***. Wrap each wire and joint tightly for a distance of about 2½" inches on each side of the joint. Make a minimum of four passes over each joint and overlap each pass approximately one inch to assure a completely watertight seal.

Installation Procedures

1. Attach the Safety Hook to the Pump



Connect the safety hook to the pump using pliers to squeeze the sides of the hook so it fits into the slot in the pump.

2. Attach the Pump to the Pipe

A back-up wrench should be used when riser pipe is attached to the pump. The pump should only be gripped by the flats on the top of the discharge chamber Under no circumstances grip the body of the pump, cable guard or motor

When tightened down, the threaded end of the first section of the riser pipe or the nipple must not come in contact with the check valve retainer in the discharge chamber of the pump. After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. Do not clamp the pump When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only. It is recommended that plastic-type riser pipe be used only with the smaller domestic submersibles. The manufacturer or representative should be contacted to ensure the pipe type and physical characteristics are suitable for this use. Use the correct joint compound recommended by the specific pipe manufacturer. Besides making sure that joints are fastened, we recommend the use of a torque arrestor when using plastic pipe.

(continued on next page)

Do not connect the first plastic riser section directly to the pump Always attach a metallic nipple or adapter into the discharge chamber. The threaded end of the nipple or adapter must not come in contact with the check valve retainer in the discharge chamber when tightened down.

3. Lower the Pump Into the Well

Make sure the electrical cables are not cut or damaged in any way when the pump is being lowered in the well. Do not use the power cables to support the weight of the pump.

To protect against surface water entering the well and contaminating the water source, the well should be finished off above grade utilizing a locally approved well seal or pitless adaptor unit We recommend that steel riser pipes always be used with the larger submersibles. A pipe thread compound should be used on all joints. Make sure that the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping and possible cable damage Nylon cable clips or waterproof tape may be used The cable splice should be protected by securing it with clips or tape just above each joint

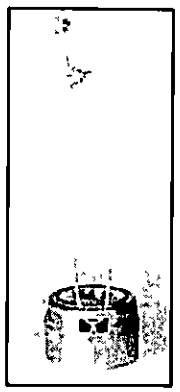


Fig 1

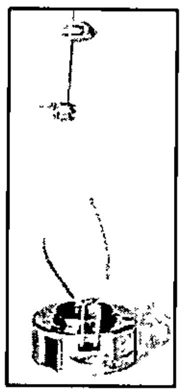


Fig 2

IMPORTANT: *Plastic pipe tends to stretch under load This stretching must be taken into account when securing the cable to the riser pipe. Leave three to four inches of slack between clips or taped points. This tendency for plastic pipe to stretch will also affect the calculation of the pump setting depth As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length When plastic riser pipe is used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge chamber of GRUNDFOS 4-inch submersibles is designed to accommodate this cable*

(See Figures 1 & 2)

Check Valves: A check valve should always be installed at the surface of the well and one at a max of 25' above static water level. In addition, for installations deeper than 200 feet, check valves should be installed at no more than 200 foot intervals.

4. Electrical Connections

WARNING Reduced risk of electric shock during operation of this pump requires the provision of acceptable grounding If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor (at least the size of the circuit supplying the pump) to the grounding screw provided within the wiring compartment

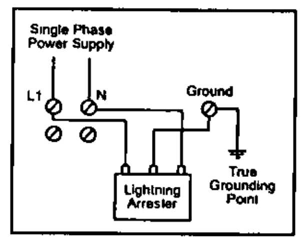
Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor. Motor electrical data can be found on page 6. If voltage variations are larger than ± 10%, do not operate the pump Single-phase motor control boxes should be connected as shown on the wiring diagram mounted on the inside cover of the control box supplied with the motor. The type of wire used between the pump control boxes should be approved for submersible pump application. The conductor insulation should be type RW, RUW, TW or equivalent.

A high-voltage surge arrestor should be used to protect the motor against lightning and switching surges. Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area. Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

The correct voltage-rated surge arrestor should be installed on the supply (line) side of the control box or starter (see Figure 3a & 3b) The arrestor must be grounded in accordance with the National Electric Code and local governing regulations.

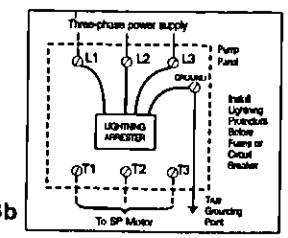
PUMPS SHOULD NEVER BE STARTED UNLESS THE PUMP IS TOTALLY SUBMERGED. SEVERE DAMAGE MAY BE CAUSED TO THE PUMP AND MOTOR IF THEY ARE RUN DRY.
The control box shall be permanently grounded in accordance with the National Electric Code and local governing codes or regulations The ground wire should be a bare stranded copper conductor at least the same size as the drop cable wire size. Ground wire should be as short a distance as possible and securely fastened to a true grounding point True grounding points are considered to be: a grounding rod driven into the water strata; steel well casing submerged into the water lower than the pump setting level; and steel discharge pipes without insulating couplings. If plastic discharge pipe and well casing are used, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel. Do not ground to a gas supply line. Connect the grounding wire to the ground point first, then to the terminal in the control box.

Fig.3a



Single Phase Hookup

Fig.3b



Three Phase Hookup

685 10

Installation Procedures

Single-Phase 2-Wire Wiring Diagram for Submersible Motors

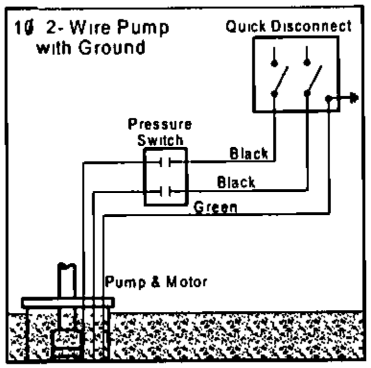


Fig.4

Three-Phase Wiring Diagram for Submersible Motors

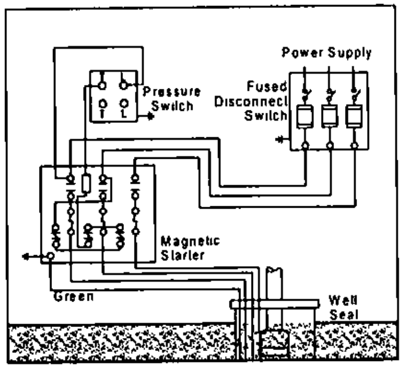


Fig.5

Single-Phase 3-Wire Control Box for Submersible Motors

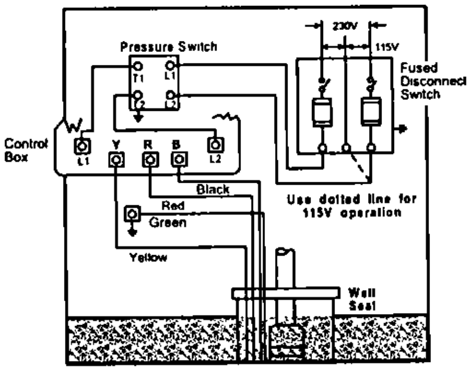


Fig.6

5. Starting the Pump for the First Time

- **A.** Attach a temporary horizontal length of pipe to the riser pipe.
- **B.** Install a gate valve and another short length of pipe to the temporary pipe
- **C.** Adjust the gate valve one-third of the way open.
- **D.** Verify that the electrical connections are in accordance with the wiring diagram.
- **E.** After proper rotation has been checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.
- **F.** Slowly open the valve in small increments as the water clears until the valve is all the way open. The pump should not be stopped until the water runs clear.
- **G.** If the water is clean and clear when the pump is first started, the valve should still be opened until it is all the way open.

Motor Information

Grundfos 4 Inch (Two-Wire) Motors 60 Hz

SINGLE-PHASE — Control Box Not Required

HP	Ph	VOLT	Ser. Fact.	Circ Brk or Stnd Fuse	Dual Element Fuse	AMPERAGE Full Load	AMPERAGE Lock Rotor	AMPERAGE S.F. Amps	FULL LOAD Eff.	FULL LOAD Power Factor	Line-to-Line Resistance(Ohms) Delta	KVA Code *	Max. Thrust (lbs)
1/3	1	230	1 75	15	5	3.4	25 7	4 6	59 0	77 0	6 3-7 6	S	750
1/2	1	230	1 60	15	7	4 55	34 5	6 0	62 0	76 0	4 0-4 7	R	750
3/4	1	230	1 50	20	9	6 9	40 5	8 4	62 0	75 0	3 1-3 7	N	750
1	1	230	1 40	25	12	8 0	48 4	9 8	63 0	82 0	2 6-3 1	M	750
1 1/2	1	230	1 30	35	15	10 0	62 0	13 1	64 0	85 0	2 0-2 3	L	750

Grundfos 4 Inch (Three-Wire*) Motors

SINGLE-PHASE — Control Box Required

HP	Ph	VOLT	Ser. Fact.	Circ Brk or Stnd Fuse	Dual Element Fuse	Full Load	Lock Rotor	S.F. Amps	Eff.	Power Factor	Blk-Yel / Red-Yel	KVA Code	Max. Thrust (lbs)
1/3	1	230	1 75	15	5	3 4	14 0	4 6	59 0	77 0	6 3-7 6/17 0-20 6	L	750
1/2	1	230	1 60	15	7	4.55	21 5	6 0	62 0	76 0	3 8-4 6/15 9-19 3	L	750
3/4	1	230	1 50	20	9	6 9	31 4	8 4	62 0	75 0	3 1-3 6/13 5-16 5	L	750
1	1	230	1 40	25	12	8 0	37 0	9 8	63 0	82 0	2 6-3 2/9 9-12 1	K	750
1 1/2	1	230	1 30	30	15	9 4	45 9	11 6	69 0	89 0	2 0-2 4/8 3-10 0	H	750

THREE-PHASE

HP	Ph	VOLT	Ser. Fact.	Circ Brk or Stnd Fuse	Dual Element Fuse	Full Load	Lock Rotor	S.F. Amps	Eff.	Power Factor	Three-Phase Overload Protection Starter Size	Furnas Amb Comp	Line to Line Resist (Ohms)	KVA Code	Max. Thrust (lbs)
1 5	3	230	1 25	20	10	5.6	40 3	7 3	75 0	72 0	0	K42	3 25	M	750
		460	1 30	10	5	2 8	20 1	3 65	75 0	72 0	00	K32	12 3	M	750
		575	1 30	8	4	2 2	16 1	2 9	75 0	72 0	00	K29	21 5	M	750
2	3	230	1.25	25	10	7 0	48 0	8 7	76 0	75 0	0	K49	2 25	L	750
		460	1.25	12	6	3 5	24 0	4 35	76 0	75 0	0	K34	9 2	L	750
		575	1 25	10	5	2 8	19 2	3 5	76 0	75 0	00	K32	13 8	L	750
3	3	230	1 15	30	15	9 6	51 0	11 2	68 5	83 8	0	K54	2 2	H	1000
		460	1 15	15	7	4 8	25 5	5 6	68 5	83 8	0	K37	9 0	H	1000
		575	1 15	15	6	3 8	20 4	4 5	68 5	83 8	0	K36	13 0	H	1000
5	3	230	1.15	40	25	15 2	89	17 8	71 9	80 0	1	K61	1 2	H	1000
		460	1 15	20	12	7 8	45	8 9	71 9	80 0	0	K50	5 0	H	1000
		575	1.15	15	9	6 1	35	7 1	71 9	80 0	0	K43	7 3	H	1000

*All Grundfos 4" motors have a ground (green) wire.

Franklin Motors

Refer to the Franklin Submersible Motors Application Maintenance Manual)

Motor Information

Maximum Cabl Length
Motor Service to Entrance
(Length in feet)

SINGLE-PHASE 60 HZ

Motor Rating		Copper Wire Size								
VOLTS	HP	14	12	10	8	6	4	2	0	00
115	1/3	130	210	340	540	840	1300	1960	2910	
	1/2	100	160	250	390	620	960	1460	2160	
230	1/3	550	880	1390	2190	3400	5250	7960		
	1/2	400	650	1020	1610	2510	3880	5880		
	3/4	300	480	760	1200	1870	2890	4370	6470	
	1	250	400	630	990	1540	2380	3610	5360	6520
	1 1/2	190	310	480	770	1200	1870	2850	4280	5240
	2	150	250	390	620	970	1530	2360	3620	4480
	3	120	190	300	470	750	1190	1850	2890	3610
	5			180	280	450	710	1110	1740	2170

THREE-PHASE 60 HZ

VOLTS	HP	14	12	10	8	6	4	2
208	1 1/2	310	500	790	1260			
	2	240	390	610	970	1520		
	3	180	290	470	740	1160	1810	
		5170	280	4690	1080			1660
230	1 1/2	360	580	920	1450			
	2	280	450	700	1110	1740		
	3	210	340	540	860	1340	2080	
	5		200	320	510	800	1240	1900
460	1 1/2	1700						
	2	1300	2070					
	3	1000	1600	2520				
	5	590	950	1500	2360			
575	1 1/2	2620						
	2	2030						
	3	1580	2530					
	5	920	1480	2330				

FOOTNOTES:

1 If aluminum conductor is used, multiply lengths by 0 5 Maximum allowable length of aluminum is considerably shorter than copper wire of same size
2 The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length to ensure reliable starter operation Single-phase control boxes may be connected at any point of the total cable length
3 Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes

Troubleshooting

SUPPLY VOLTAGE

How to Measure
By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box On single-phase units, measure between line and neutral

What it Means
When the motor is under load, the voltage should be within 10% of the nameplate voltage Larger voltage variation may cause winding damage Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected
If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage

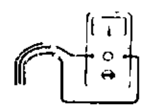
CURRENT MEASUREMENT

How to Measure
By use of an ammeter, set on the proper scale, measure the current on each power lead at the control box See page 6, for motor amp draw information
Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded

What it Means
If amp draw exceeds the listed service factor amps (SFA), check for the following

1 Loose terminals in control box or possible cable defect
Check winding and insulation resistances
2 Too high or low supply voltage
3 Motor windings are shorted
4 Pump is damaged causing a motor overload

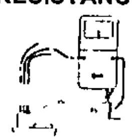
WINDING RESISTANCE



How to Measure
Turn off power and disconnect the drop cable leads in the control box Using an ohmmeter, set scale selectors to Rx1 for values under 10 ohms and Rx10 for values over 10 ohms.
Zero-adjust the meter and measure the resistance between leads Record the values Motor resistance values can be found on page 6

What it Means
If all the ohm values are normal, and the cable colors are correct, the windings are not damaged If any one ohm value is less than normal, the motor may be shorted If any one ohm value is greater than normal, there is a poor cable connection or joint The windings or cable may also be open
If some of the ohm values are greater than normal and some less, the drop cable leads are mixed To verify lead colors, see resistance values on page 6

INSULATION RESISTANCE



How to Measure
Turn off power and disconnect the drop cable leads in the control box Using an ohm or mega ohmmeter, set the scale selector to Rx100k and zero-adjust the meter Measure the resistance between the lead and ground(discharge pipe or well casing,if steel)

What it Means
For ohm values, refer to table below Motors of all Hp, voltage, phase and cycle duties have the same value of insulation resistance

OHM VALUE	MEGOHM VALUE	CONDITION OF MOTOR AND LEADS
		Motor not yet installed
2,000,000(or more)	2 0	New Motor
1,000,000(or more)	1 0	Used motor which can be reinstalled in the well
		Motor in well (Ohm readings are for drop cable plus motor)
500,000-1,000,000	0 5-1 0	A motor in reasonably good condition
20,000-50,000	0 02-0 5	A motor which may have been damaged by lightning or with damaged leads Do not pull the pump for this reason
10,000-20,000	0 01-0 02	A motor which definitely has been damaged or with damaged cable The pump should be pulled and repairs made to the cable or the motor replaced. The motor will still operate, but probably not for long
less than 10,000	0-0 01	A motor which has failed or with completely destroyed cable insulation The pump must be pulled and the cable repaired or the motor replaced. The motor will not run

685 12

Pump Won't Start

Possible Cause	Check This By ...	Correct This By ...
No power at the motor	Check for voltage at the control box or panel	If there is no voltage at the control panel, check the leeder panel for tripped circuits and reset those circuits
Fuses are blown or the circuit breakers have tripped.	Turn off the power and remove the fuses Check for continuity with an ohmmeter	Replace the blown fuses or reset the circuit breaker If the new fuses blow or the circuit breaker trips, the electrical installation motor, and wires must be checked for defects
(3-phase motors only) Motor starter overloads are burned or have tripped	Check for voltage on the line and load side of the starter Check the amp draw and make sure the heater is sized correctly	Replace any burned heaters or reset Inspect the starter for other damage If the heater trips again, check the supply voltage Ensure that heaters are sized correctly and the trip setting is appropriately adjusted
(3-phase motors only) Starter does not energize	Energize the control circuit and check for voltage at the holding coil.	If there is no voltage check the control circuit fuses If there is voltage check the holding coil for weak connections Ensure that the holding coil is designed to operate with the available control voltage Replace the coil if defects are found.
Defective controls	Check all safety and pressure switches for defects Inspect the contacts in control devices	Replace worn or defective parts or controls
Motor or cable is defective	Turn off the power and disconnect the motor leads from the control box Measure the lead-to-lead resistance with an ohmmeter (set to R x 1) Measure the lead-to-ground values with an ohmmeter (set to R x 100K)	If an open or grounded winding is found remove the motor from the well and recheck the measurements with the lead separated from the motor Repair or replace the motor or cable
(1-phase motors only) Defective capacitor	Turn off the power and discharge the capacitor by shorting the leads together Check it with an analog ohmmeter (set to R x 100K)	When the meter is connected to the capacitor the needle should jump toward 0 (zero) ohms and slowly drift back to infinity (∞). Replace capacitor if it is defective.
Defective pressure switch or the tubing to it is plugged.	Watch the pressure guages as the pressure switch operates Remove the tubing and blow through it.	Replace as neccessary
The pump is mechanically bound or stuck	Turn off the power and manually rotate the pump shaft Also check the motor shaft rotation, the shaft height, and the motor's amp draw (to see if it indicates a locked rotor)	If the pump shaft doesn't rotate, remove the pump and examine it If necessary dismantle it and check the impellers and seal for obstruction. Check for motor corrosion

Pump Does Not Produce Enough Flow (GPM)

Possible Cause	Check This By ...	Correct This By ...
(3-phase motors only) Shaft is turning in the wrong direction.	Check to make sure the electrical connections in the control panel and correct	Correct the wiring For single phase motors check the wiring diagram on the motor For three phase motors simply switch any two power leads
Pump is operating at the wrong speed (too slow)	Check for low voltage and phase imbalance	Replace defective parts or contact power company as applicable
Check valve is stuck (or installed backwards)	Remove the check valve	Re-install or replace
Parts or fittings in the pump are worn or Impellers or Inlet Strainer is clogged	Install a pressure gauge near the discharge port, start the pump, and gradually close the discharge valve. Read the pressure at shutoff (Do not allow the pump to operate for an extended period at shutoff)	Convert the PSI you read on the gauge to Feet of Head by $\frac{\text{PSI} \times 2.31\ \text{ft/PSI}}{\text{Specific Gravity}} = \_\_\_\_\ \text{ft.}$ Add to this number the number of feet (vertically) from the guage down to the water's pumping level Refer to the pump curve for the model you are working with to determine the shutoff head to should expect for that model If that head is close to the figure you came up with (above), the pump is probably OK If not, remove the pump and inspect impellers chambers, etc.
The water level in the well may be too low to supply the flow desired or Collapsed well	Check the drawdown in the well while the pump is operating.	If the pumping water level (including drawdown) is not **AT LEAST 3 FEET** above the pump's inlet strainer either 1 Lower the pump further down the well 2 Throttle back the discharge valve to decrease the flow thereby reducing drawdown
Broken shaft or coupling	Pull pump and inspect	Replace as necessary
There are leaks in the fittings or piping	Pull the pump out of the well.	The suction pipe valves, and fittings must be made tight Repair any leaks and retighten all loose fittings

Fuses Blow or Heaters Trip

Possible Cause	Check This By ...	Correct This By ...
Improper voltage	Check the voltage at the control box or panel	If the voltage varies by more than 10% (+ or -), contact the power company
	If the incoming voltage is OK, check the wire size and the distance between the pump motor and the pump control panel	Rewire with correct guage Undersized wire and a great distance between the control panel and the pump motor increases resistance and decreases the voltage by the time it reaches the pump motor
The starter overloads are set too low	Cycle the pump and measure the amperage	Increase the heater size or adjust the trip setting Do not however, exceed the recommended rating
(3-phase motors only) The three-phase current is imbalanced	Check the current draw on each lead to the motor	The current draw on each lead must be within 5% of eachother (+ or -) If they are not check the wiring
The wiring or connections are faulty	Check to make sure the wiring is correct and there are no loose terminals	Tighten any loose terminals and replace any damaged wire
(1-phase motors only) Capacitor is defective	Turn off the power and discharge the capacitor Check the capacitor with an ohmmeter (set at R x 100K). See page 15 for instructions	When the meter is connected to the capacitor the needle should jump towards 0 (zero) ohms and then slowly drift back to infinity (∞) Replace the capacitor if it is defective.
Fuse, heater, or starter are the wrong size	Check the fuses and heaters against the motor manufacturer's specification charts	Replace as necessary
The control box location is too hot	Touch the box with your bare hand during the hottest part of the day -- you should be able to keep your hand on it without burning	Shade ventilate or move the control box so its environment does not exceed 120°F
(1-phase motors only) Wrong control box	Check requirements for the motor against the control box specificatons	Replace as necessary
Defective pressure switch	Watch guages as pressure switch operates	Replace as necessary
The motor is shorted or grounded.	Turn off the power and disconnect the wiring Measure the lead-to-lead resistance with an ohmmeter (set to R x 1) Measure the lead-to-ground resistance with an ohmmeter (set to R x 100K) or a megaohmmeter Compare these measurements to the rated values for your motor	If you find an open or grounded winding, remove the motor and recheck the leads If OK, check the leads for continuity and for bad splice
Poor motor cooling	Find the internal diameter of the well casing (or sleeve if used) For proper cooling, the flow of water must not be less than the GPM shown across the bottom scale on page ___	Throttle up the pump flow (GPM) so proper cooling is possible or Pull the pump out of the well and add a sleeve with a smaller internal diameter

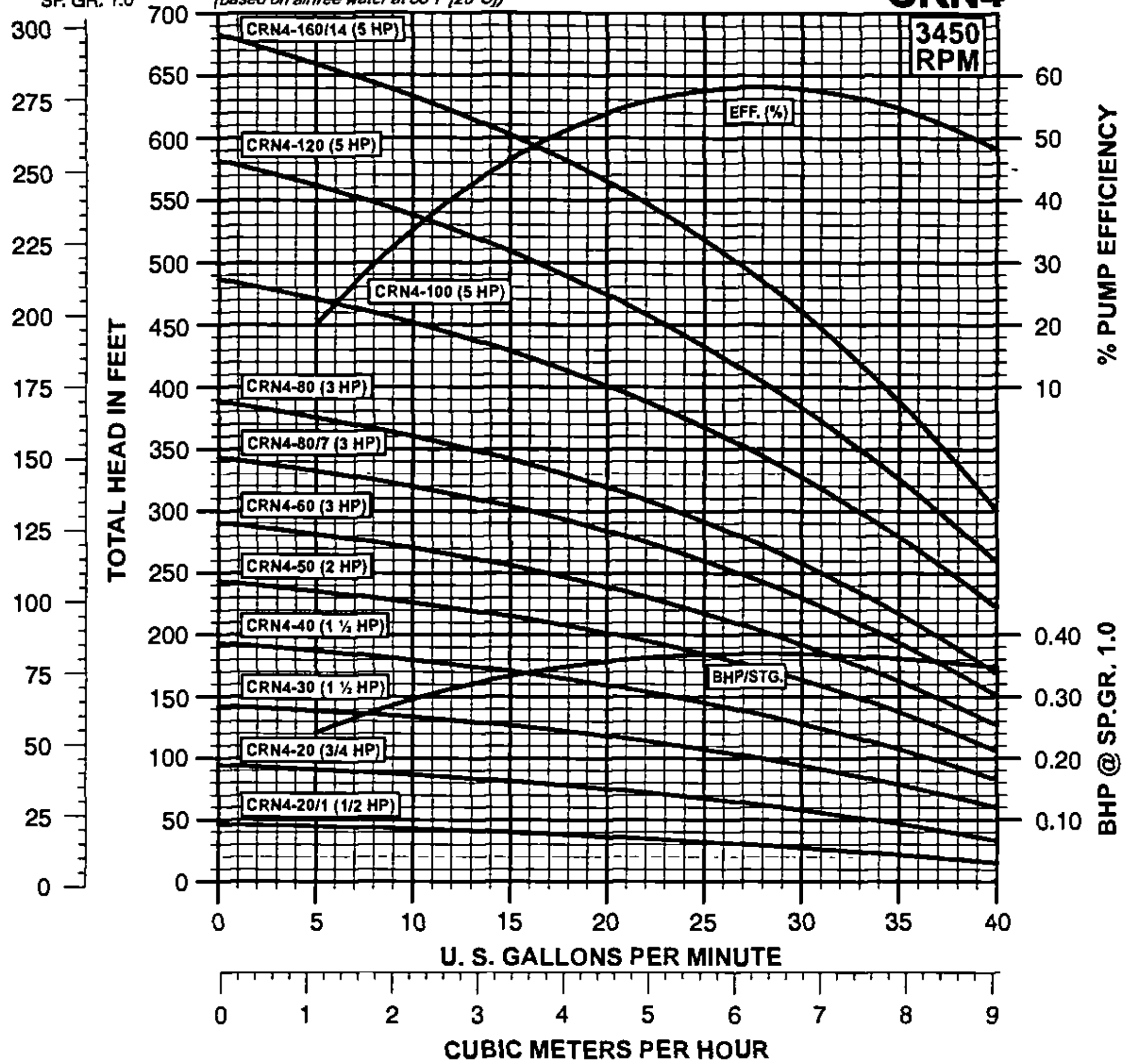
Pump Cycles Too Often

Possible Cause	Check This By ...	Correct This By ...
The pressure switch is defective or is not properly adjusted.	Check the pressure setting on the switch Check the voltage across closed contacts	Readjust the pressure switch or replace it if defective
The tank is too small	Check the tank size and amount of air in the tank The tank volume should be approximately 10 gallons for each Gallon Per Minute of pump capacity At the pump cut-in pressure the tank should be about 2/3 filled with air	Replace the tank with one that is the correct size
There is insufficient air charging of the tank or piping is leaking.	Pump air into the tank or diaphragm chamber Check the diaphragm for leaks Check the tank and piping for leaks with soapy water Check the air to water ratio in the tank	Repair as necessary
Plugged snifter valve or bleed orifice (causing pressure tank to be waterlogged)	Examine them for dirt or erosion	Repair or replace as neccessary
Leak in the pressure tank or piping.	Apply soapy water to pipes and tank then watch for bubbles indicating leaks	Repair or replace as necessary
The level control is defective or is not properly set.	Check the setting and operation of the level control	Readjust the level control setting (according to the manufacturer's instructions) or replace it if defective
Pump is oversized for the application It is outpumping the yield of the well and pumping itself dry.	Check the yield of the well (determined by the well test) against the pump's performance curve	Reduce the flow by throttling back the valve or Change the pump

Performance Curves

(based on airfree water at 68°F [20°C])

CRN4



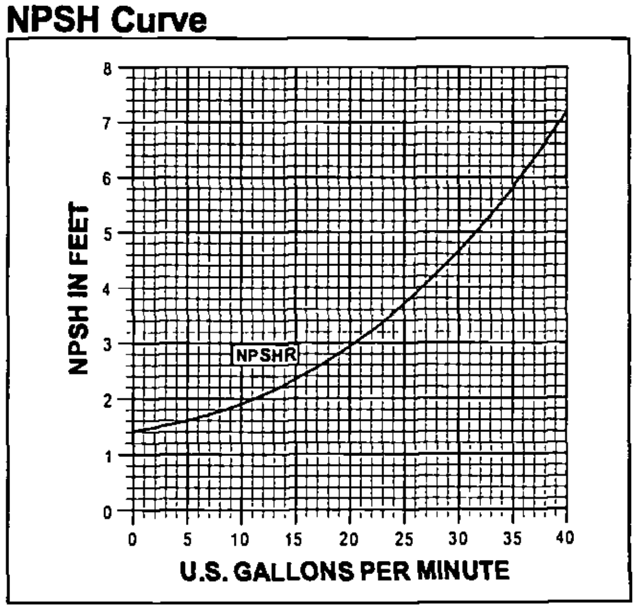
Materials of Construction

DESCRIPTION	MATERIAL
Motor Stool and Couplings (not in contact with Pumping Medium)	Cast Iron
Suction/Discharge Base, Impellers, Intermediate Chambers, Spacing Pipes, Outer Sleeve, Priming Valve, & Pump Head Cover	AISI 316 SS
Coupling Guards	AISI 304 SS
Pump Shaft	AISI 316 SS
O-Ring Type Shaft Seal ***(Optional: Bellows Type Shaft Seal, Carbon/Tungsten Carbide, EPDM & FPM)***	
- Stationary Face	Tungsten Carbide
- Rotation Face	Tungsten Carbide
- O-Rings	EPDM (FPM Optional)
- Upper and Lower Drivers	AISI 316 SS
- Spring	AISI 316 SS
Intermediate Chamber Bearings	Aluminum Oxide Ceramic
Intermediate Bearing Journals	Tungsten Carbide
O-Rings	EPDM (FPM Optional)
Base Plate	Steel
Outer Sleeve Gaskets	Non-Asbestos Fiber
Air Vent Plug	AISI 316 SS
Neck Rings	Teflon ®

NOTES EPDM–Ethylene Propylene Rubber • ® Registered trademark of DuPont

Recommended Spare Parts: Stack Kit & Shaft Seal/Gasket Kit

NPSH Curve



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Canada: Oakville, Ontario • **Mexico:** Apodaca, N L

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PRINTED IN USA

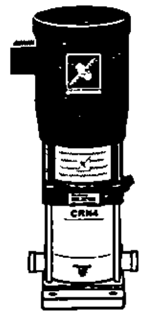
685 15

GRUNDFOS®

Series C Multi-Stage C ntrifugal Pumps

CRN4
316 Stainless Steel

Submittal Data 3450 RPM 60 Hertz

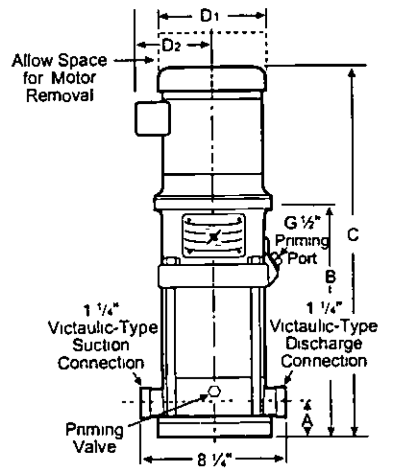


JOB or CUSTOMER:	
ENGINEER:	
CONTRACTOR:	
SUBMITTED BY:	DATE:
APPROVED BY:	DATE:
ORDER NO:	DATE:
SPECIFICATION REF:	

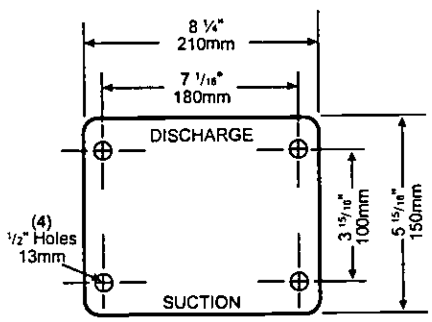
QUANTITY	TAG NO.	MODEL NO.	GPM	FEET	VOLT	PHASE	COMMENTS

"STACK" KIT P/N SEAL & GASKET KIT P/N:

Dimensions



Base Dimensions



Technical Data

(based on airfree water at 68°F [20°C])

MIN. DUTY FLOW RATE:
5°F to 250°F (-15°C to 120°C) = 2 0 GPM
See the Series C Installation & Operating Manual for operating limits below this minimum

MOTORS: ODP (Standard), TEFC (Optional)

TEMPERATURE RANGE:
5°F to 250°F (-15°C to 121°C)

FITTINGS: 1 ¼" Victaulic-Type

MAX. WORKING PRESSURE (at 250°F)·
Models 20/1 - 100 230 PSI (16 Bars)
120 - 160/14 300 PSI (20 Bars)

(Consult Grundfos for maximum working pressures at lower fluid temperatures)

MAX. INLET PRESSURE:
20/1-20 90 PSI (6 Bars)
30-80/7 145 PSI (10 Bars)
80-160/14 220 PSI (15 Bars)

Motors are UL / CSA Rated

Electrical Data, Dimensions, and Weights①

Pump Type	HP	Motor S.F.	Ph	Volts	NEMA Frame Size	DIMENSIONS IN INCHES: Disc. Size	Suc. Size	Motor Height	A	B	C	D1	D2	Net Wt. (Lbs.)	Ship. Wt. (Lbs.)	Ship. Vol. (Cu. Ft.)
CRN4-20/1	½	1 25	1	115/208-230	56C	1 ¼	1 ¼	9 ⅜	2	9 ½	18 ⅞	6 ⅛	4 ⅜	43	49	4
	½	1 25	3	208-230/460	56C	1 ¼	1 ¼	9 ⅜	2	9 ½	18 ⅞	6 ⅛	4 ½	42	48	4
CRN4-20	¾	1 25	1	115/208-230	56C	1 ¼	1 ¼	10 ¼	2	9 ½	19 ¾	6 ⅛	4 ½	47	53	4
	¾	1 25	3	208-230/460	56C	1 ¼	1 ¼	9 ⅜	2	9 ½	18 ⅞	6 ⅛	4 ½	53	59	4
CRN4-30	1 ½	1 15	1	115/208-230	56C	1 ¼	1 ¼	11 ¼	2	10 ⅜	21 ⅝	7 ¼	5 ¼	59	65	4
	1 ½	1 15	3	208-230/460	56C	1 ¼	1 ¼	9 ⅜	2	10 ⅜	19 ¾	5 ⅞	4 ⅜	55	61	4
CRN4-40	1 ½	1.15	1	115/208-230	56C	1 ¼	1 ¼	11 ¼	2	12 ⅜	23 ⅝	7 ¼	5 ¼	64	70	4
	1 ½	1 15	3	208-230/460	56C	1 ¼	1 ¼	9 ⅜	2	12 ⅜	21 ¾	5 ⅞	4 ⅜	60	67	4
CRN4-50	2	1 15	1	115/208-230	56C	1 ¼	1 ¼	11 ¼	2	13 ⅜	24 ⅝	6 ⅝	5 ¼	72	80	4
	2	1 15	3	208-230/460	56C	1 ¼	1 ¼	10 ⅜	2	13 ⅜	23 ¾	6 ⅝	5 ¼	64	71	4
CRN4-60	3	1 15	1	115/208-230	182TC	1 ¼	1 ¼	14	2	14 ⅝	28 ⅝	8 ½	5 ⅞	107	115	6
	3	1 15	3	208-230/460	182TC	1 ¼	1 ¼	11 ⅜	2	14 ⅝	26	8 ½	5 ⅞	77	85	6
CRN4-80/7	3	1 15	1	115/208-230	182TC	1 ¼	1 ¼	14	2	16 ½	30 ½	8 ½	5 ⅞	108	116	6
	3	1 15	3	208-230/460	182TC	1 ¼	1 ¼	11 ⅜	2	16 ½	27 ⅞	8 ½	5 ⅞	78	88	6
CRN4-80	3	1 15	1	115/208-230	182TC	1 ¼	1 ¼	14	2	16 ½	30 ½	8 ½	5 ⅞	111	119	6
	3	1 15	3	208-230/460	182TC	1 ¼	1 ¼	11 ⅜	2	16 ½	27 ⅞	8 ½	5 ⅞	81	89	6
CRN4-100	5	1 15	1	208-230	213TC	1 ¼	1 ¼	16	2	18 ⅞	34 ⅞	10 ⅛	7 ⅜	145	158	7
	5	1 15	3	208-230/460	184TC	1 ¼	1 ¼	13 ¾	2	18 ⅞	33	9	5 ¾	114	126	7
CRN4-120	5	1 15	1	208-230	213TC	1 ¼	1 ¼	16	2	21 ⅛	37 ⅛	10 ⅛	7 ⅜	147	159	7
	5	1 15	3	208-230/460	184TC	1 ¼	1 ¼	13 ¾	2	21 ⅛	35 ¼	9	5 ¾	116	130	7
CRN4-160/14	5	1 15	1	208-230	213TC	1 ¼	1 ¼	16	2	23	39	10 ⅛	7 ⅜	155	167	8
	5	1 15	3	208-230/460	184TC	1 ¼	1 ¼	13 ¾	2	23	37 ⅛	9	5 ¾	124	138	8

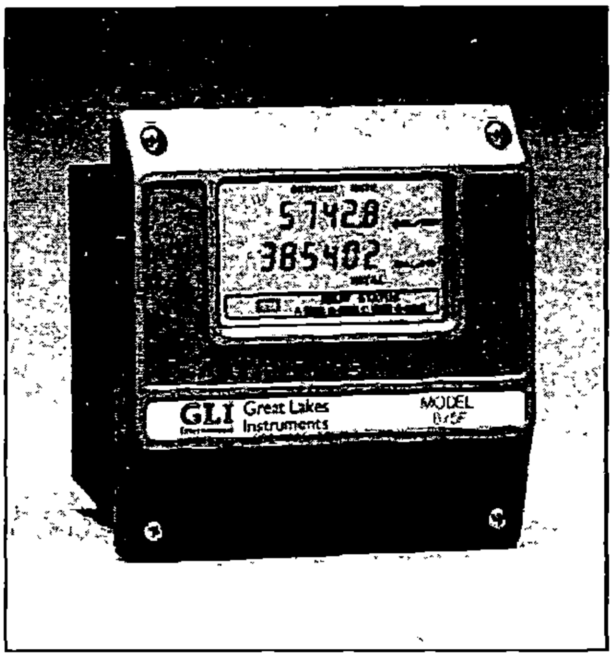
NOTE ①Above data for Baldor ODP motors

GLI International

Technology For Solutions

Data Sheet 675F/1197
Supersedes 675F/896

Model 675F
Digital Flow Monitor/Totalizer



Certified by CSA for General Purpose use

■ **Two Measurement Readouts.** The Model 675F microprocessor-based monitor/totalizer features a digital LCD that simultaneously displays the measured flow rate (upper readout) and the total accumulated flow (lower readout)

■ **Control and Alarm Capability.** Two SPDT relays can be independently set to operate in response to increasing or decreasing flow rate.

■ **Standard Multiple Outputs.** The Model 675F provides three analog outputs: 4-20 mA, 0-100 Hz., and a retransmitted flow input signal that is LSTTL-compatible. Additionally, the instrument has a scaleable pulse output to provide one 24 VDC pulse each time the total accumulated flow increases by a user-set volume. The duration of the pulse is adjustable from 0 1 to 2 5 seconds.

■ **Simple Pushbutton Operation.** Menu-driven operation makes the Model 675F simple to use. Five pushbuttons (located behind the enclosure door) configure the instrument and conveniently recall stored setup values.

■ **Versatile Input Capability.** The Model 675F can be used with most brands of flow sensors. It accepts these types of input signals:

- Isolated 4-20 mA
- 0-2000 Hz. (typical of most turbine flow sensors)
- 0-200 Hz (provided by all GLI impeller flow sensors)
- TTL-compatible 0-200 Hz.

■ **Resettable Total Accumulated Flow.** The accumulated flow total can be reset using a specific pushbutton sequence, or a switched input signal from a remote location

■ **NEMA 4X Protection.** The NEMA 4X enclosure protects the instrument circuitry from harsh environments. Also, the hinged cover is easily removed to facilitate installation and servicing.

■ **Universal Mounting.** Two stainless steel brackets enable the monitor/totalizer to be surface, panel or horizontal pipe mounted. Vertical pipe mounting requires optional hardware

Specifications

Operational:

Display .... . Two-line LCD with 7 digits per line; 3/8 inch (9 5 mm) high digits;
1st line Shows flow rate in GPM, liters per minute, or other measurement units
2nd line· Shows total accumulated flow in U S gallons, liters, or other measurement units

Ambient Conditions........ . ... -22 to 122°F (-30 to 50°C), 0-100% relative humidity, non-condensing

Relay Function·

Setpoints .... Selectable, 0-100% of measuring scale

Deadbands . ... Selectable, 0-20% of measuring scale span

Indicators .. . . LED lights when respective relay is on

Outputs .. .. Two SPDT contact outputs, U.L rating:
5A 115/250 VAC, 5A @ 30 VDC resistive

NOTE: *Relays can be switch selected to operate in response to increasing or decreasing flow rate*

Sensor-to-Analyzer Distance .. .. GLI impeller flow sensors. 2000 ft. (610 m) maximum
Turbine flow sensors· 300 ft (91 m) maximum

Power Requirements... . ... 98-137 VAC, 50/60 Hz (less than 8 VA);
optional 195-275 VAC, 50/60 Hz - or - 24 VDC (150 mA max.)

Signal Inputs

Standard . ... 0-2000 Hz from inductive pickup (turbine flow sensors)
0-200 Hz conditioned pulse signal (GLI impeller flow sensors)
0-200 Hz from TTL-compatible flow signal source

Optional . . .. Transmitted, linear 4-20 mA (isolated) flow signal; 50 ohm input impedance

Outputs

Analog . . . 4-20 mA, 625 ohms maximum load
0-100 Hz., TTL or 24 VDC compatible
Retransmitted flow input signal, LSTTL-compatible

Scaleable Pulse ... . . . 24 VDC pulse (30 mA max) occurs each time total accumulated flow increases by user-set volume; adjustable pulse duration of 0 1 to 2 5 seconds

Electrical Certification (optional) CSA General Purpose

Analyzer Performance (Electrical, Analog Outputs):

Sensitivity .... . . 0.1% of span

Stability .. . . 0 1% of span per 24 hours, non-cumulative

Non-linearity. . ... 0 1% of span

Repeatability . .. . 0.1% of span or better

Temperature Drift ... . Zero. 0 02% of span per °C,
Span· 0.01% of span per °C

Response Time .... 3 seconds to 90% of value on increasing flow rate;
2 seconds to 90% of value on decreasing flow rate

Mechanical:

Enclosure .... NEMA 4X, 1/2 DIN, polycarbonate case with two 1/2-inch conduit holes and two stainless steel mounting brackets

Mounting Configurations . .. . Surface, panel, and horizontal ppe mount, vertical pipe mounting requires optional hardware

Net Weight. . . . . 3 lbs (1 36 kg) approximately

Ordering Information

MODEL NUMBER
675F Microprocessor-based monitor/totalizer in NEMA 4X, 1/2 DIN enclosure with stainless steel mounting brackets for panel, surface and horizontal pipe mounting

INPUT CAPABILITY
3C Accepts 0-2000 Hz (turbine), 0-200 Hz. (GLI impeller), and 0-200 Hz from TTL-compatible source
4C Same as 3C above, plus accepts transmitted, linear 4-20 mA (isolated) flow signal

LINE VOLTAGE
1 115 volts, 50/60 Hz.
2 230 volts, 50/60 Hz
3 24 VDC

RELAYS
B0 Two control relays

EQUIPMENT TAGGING (specify tag data)
N None
P Paper
S Stainless steel

AGENCY CERTIFICATION
N None
C CSA Certified (safe area use only)

675F			B0		

Product Number (see Notes below)

Choose one from each category.

NOTES: When ordering, please provide the following information·

1. When Model 675F is used with·
   A GLI Flow Sensor The sensor model number, and the inside diameter of the pipe in which the serer is installed
   B Other Sensor Brand The sensor signal frequency per U S GPM or the U S GPM per Hz
2. The desired flow rate measuring range including·
   A Its full-scale value
   B Its units of measure (cubic ft /minute, liters/hour, etc)
   C Its display resolution (whole units, tenths, hundredths, etc)

Accessories (ordered separately):

- **Panel Cutout Gasket Kit 1000G1110**

  For use when panel mounting Model 675F to provide NEMA 4 integrity behind the panel Kit includes neoprene gasket and aluminum stiffener plate

- **Vertical Pipe-Mount Kit 1000A1077**

  For use when mounting Model 675F to a vertical pipe Kit includes vertical pipe mounting bracket and associated hardware.

- **Impeller Flow Sensors**

  For GLI tee-mount flow sensors (for 1/2 to 4 inch pipe sizes), refer to data sheet F1A11

  For GLI "hot tap" and pipe thread flow sensors (for 3 to 100 inch pipe sizes), refer to data sheet F1A13

Engineering Specification

1 The flow rate monitor/totalizer shall have a two-line LCD display with seven 3/8 inch (9 5 mm) high digits per line The upper line shall display flow rate in GPM, LPM or other measurement units The lower line shall display total accumulated flow in U S gallons, liters or other measurement units

2 The flow rate monitor/totalizer shall simultaneously display the flow rate and total accumulated flow

3 The flow rate monitor/totalizer shall have two SPDT relays which can be independently configured to operate in response to increasing or decreasing flow rate Each relay shall have setpoint and deadband adjustments

4 The flow rate monitor/totalizer shall have three analog outputs (4-20 mA, 0-100 Hz , and an LSTTL-compatible retransmitted flow input signal), and a 24 VDC scaleable pulse output with adjustable duration (0 1 to 2 5 seconds)

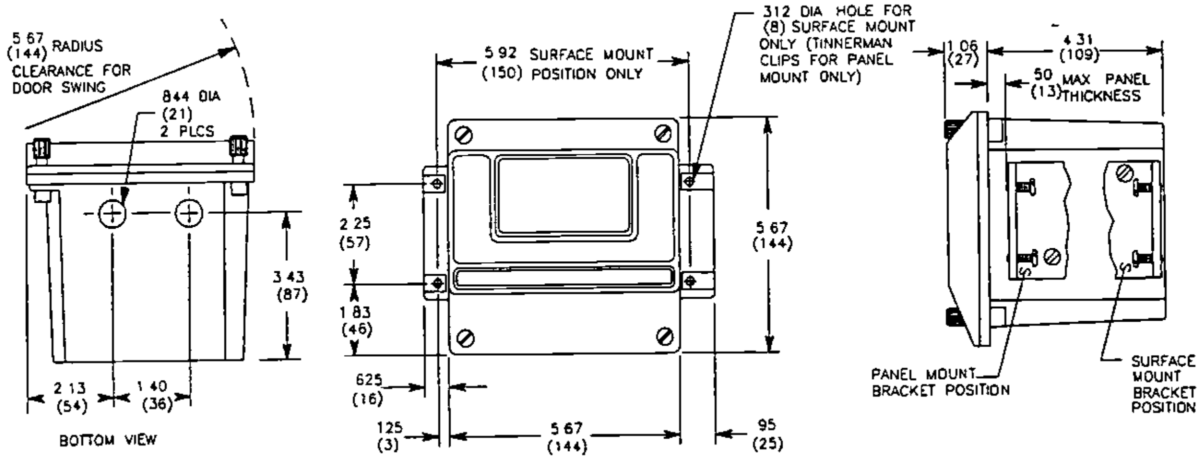
5 The flow rate monitor/totalizer shall operate on
a) 115 volts, 50/60 Hz
b) 230 volts, 50/60 Hz
c) 24 VDC

6 The flow rate monitor/totalizer enclosure shall be NEMA 4X, 1/2 DIN size and include hardware for panel, surface or pipe mounting

7 The flow rate monitor/totalizer shall be GLI International, Inc Model 675F

685 19

Dimensions
Inches (mm)



Panel Cutout 5 43 in (138 mm) square

Data Sheet 675F

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GREAT LAKES INSTRUMENTS

685 2.0

OPERATING INSTRUCTION MANUAL

Manual No. 188
Revision 11-1094

MODEL 675F
FLOW MONITOR/TOTALIZER

Great Lakes Instruments, Inc.
9020 West D... Road, Milwaukee, Wisconsin 53224 • Telephone (414) 355-3601 • Telefax (414) 355-8346

CONDENSED OPERATING INSTRUCTIONS

This manual contains detailed instructions for all operating aspects of the instrument. The following condensed instructions are provided to assist the operator in getting the instrument started up and running as quickly as possible. This pertains to basic operation only. If specific instrument features are to be used, refer to the appropriate sections in the manual for complete details.

A. CONNECTING FLOW INPUT SIGNAL

After the 675F is properly mounted (Part Two, Section 2), refer to the category below that matches the flow signal source you're using for hook-up instructions.

1. GLI Impeller Flow Sensor Or Any Turbine Flowmeter

   Connect GLI impeller flow sensor or any turbine flowmeter to SENSOR INPUT Terminals 1, 2 and 3 on TB2, matching colors as indicated.

2. Transmitted 4-20 mA Flow Input Signal (Linear or Square Root)

   The 4-20 mA flow input signal can be connected two ways:

   A. When Transmitter Is Separately Powered

      Connect 4-20 mA flow signal wires to SENSOR INPUT Terminals 1 and 2 on TB2, matching polarity as indicated.

   B. When Model 675F Powers The Transmitter

      1. Connect signal's positive (+) wire to Terminal 7 on TB1.
      2. Connect signal's negative (–) wire to Terminal 1 on TB2.

      NOTE: This wiring arrangement prevents use of RELAY C COIL terminals.

3. TTL-Compatible Input From Non-GLI Flowmeter

   Connect flow signal wires to AUX. INPUT Terminals 4 and 5 on TB2, matching polarity as indicated.

B. CONFIGURING THE FLOW INPUT

1. Setting The **INPUT SELECT** Switches

   (When the 675F has the square root input option, these switches are deleted and the flow input signal need not be configured.) These switches, located behind the power supply board (Figure 3-2), configure the 675F for the type of flow signal source being used. Find the **INPUT SELECT** switch arrangement on page 20 that corresponds to the input you're using and set switches to the positions shown.

   NOTE: If a GLI impeller flow sensor was delivered with the 675F, these switches are factory-set and need not be changed.

CONDENSED OPERATING INSTRUCTIONS (Continued)

2. Entering SLOPE, OFFSEt and UOL./PLS. Setup Values

   Refer to Part Three, Section 2.3 for instructions to determine and enter this set of three setup values which calibrates the 675F to the specific flow signal source you're using.

C. SCALING THE FLOW RATE AND TOTAL FLOW DISPLAYS

For scaling instructions, refer to the category below that matches the flow signal source you're using.

1. GLI Impeller Flow Sensor

   The 675F is factory-scaled when it is included with a GLI impeller flow sensor. Scaling by the operator is normally not required unless the pipe inside diameter of an <u>insertion-mount</u> installation changes or the 675F has lost line power <u>and</u> its battery backup. If either situation occurs, refer to Part Three, Sections 3 and 4 for complete display scaling instructions.

2. Turbine Flowmeter

   When the 675F is used with any turbine flowmeter, it is <u>not</u> factory-scaled. The operator must scale the 675F. Refer to Part Three, Sections 3 and 4 for instructions.

3. Transmitted 4-20 mA Flow Input Signal (Linear or Square Root)
   --or--
   TTL-Compatible Input From Non-GLI Flowmeter

   The operator must scale the 675F. Refer to Part Three, Sections 3 and 4 for instructions.

D. RELAY SETUP

To set the instrument's fully programmable relays to control or alarm flow rate, refer to Part Three, Section 6.

685 23

TABLE OF CONTENTS

PART ONE - INTRODUCTION

PART TWO - INSTALLATION

PART THREE - OPERATION

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

PART FOUR - OPERATING AIDS

PART FIVE - PRINCIPLE OF OPERATION

PART SIX - SERVICE AND MAINTENANCE

PART SEVEN - SPARE PARTS AND ACCESSORIES

TABLE OF CONTENTS (Continued)

PART ONE - INTRODUCTION

SECTION 1 - GENERAL INFORMATION

1.1 Instrument Capability

The instrument measures flow rate which is displayed along with the total accumulated flow. Five pushbuttons are provided to set up the 675F and recall entered values. The displayed total accumulated flow can be reset to zero by performing a special pushbutton routine. When the 675F is specifically set up, the total may be reset from a remote location via a contact (switch) closure. Also, the 675F may have an optional push-button mounted in the enclosure door to reset the total.

The LCD readout can indicate flow rate in gallons per minute or liters per minute. For other units of measure, an appropriate label is placed over the units annunciator. Display resolution is selectable with a movable decimal point. A "X10" multiplier annunciator with selectable exponent can be displayed to accommodate very large total accumulated flow values.

Input Versatility

The 675F can be used with any GLI impeller flow sensor or any turbine flowmeter. It will also accept any TTL-compatible input signal of less than 200 Hz that represents the flow rate. When the 675F is equipped with the 4-20 mA input option, a transmitted, linear 4-20 mA flow signal can be used for the input.

The square root extractor input option, if provided, allows the 675F to be used with a 4-20 mA signal that is proportional to the square of the flow rate. This type of signal is produced by an orifice plate flowmeter coupled with a differential pressure transducer.

Output Flexibility

Instrument outputs which are proportional to the flow rate include 4-20 mA, a TTL or 24 VDC compatible 0-100 Hz signal and a LSTTL-compatible retransmission of the flow input signal.

The 675F can also generate a scalable, repetitive 24 VDC pulse output. A pulse is provided every time the total flow increases by a user-selected volume. The pulse output mode (on pulse or off pulse) and pulse duration is also selectable.

The 675F has two fully programmable SPDT relays. Each relay can be set up with a setpoint, deadband and a low or high operating mode. The low mode selects the relay to trip in response to decreasing flow rate; the high mode in response to increasing flow rate. Instrument display LED's light to indicate relay "on" status.

Operator Safety

Modular construction simplifies field servicing and provides electrical safety for the operator. The display module assembly (Figure 3-1) contains voltages no greater than 24 VDC and is safe to handle. The display module assembly is removable to access the terminal strips on the power-supply board. The relays are located on the backside of the power-supply board.

WARNING: REMOVE LINE POWER BEFORE HANDLING POWER-SUPPLY BOARD TO AVOID ELECTRICAL SHOCK.

1.2 Battery Back-up

A rechargeable nickel-cadmium battery on the backside of the display board retains all user-entered setup values in memory for up to 5 months (at 25°C), even if power is lost or turned off. The 10-year battery is continually trickle-charged whenever line power is applied. A completely discharged battery recharges fully after 48 hours of instrument operation. A **BATTERY ON/OFF** jumper is located next to the battery's "+" lead to disconnect the battery when the 675F is not used for an extended time.

NOTE: If the 675F is operated with the battery switched off, user-entered values are stored only as long as line power is applied. When line power is removed, all stored values will be lost. Factory-set defaults will replace all user-entered values when line power is re-applied.

1.3 Product Identification

The serial # of your 675F is located on the backside of the display module assembly (Figure 3-2). When a GLI impeller flow sensor is used, the mounting tee number or inside diameter of the pipe in which the sensor is to be installed is also shown. This information is needed for 675F input configuration. The remaining setup variables, determined by your application circumstances, can be written in the "Record Your Entry" column in Appendix 1 of this manual for handy reference. The matrix below lists all instrument options. Refer to it when re-ordering. Write the serial # in the space provided below the matrix for convenient identification. Should technical assistance be required, please provide the GLI Customer Service Department with this information.

MODEL NUMBER
675F Microprocessor-based monitor/totalizer in NEMA 4X, 1/2 DIN enclosure with stainless steel brackets for panel, surface or horizontal pipe mounting.

INPUT CAPABILITY
- 3C Accepts 0-2000 Hz (turbine), 0-200 Hz (GLI impeller) and 0-200 Hz from TTL-compatible source
- 4C Same as 3C above, plus accepts transmitted, linear 4-20 mA signal
- 5C Square Root Input Extractor (for use with a 4-20 mA input signal that is proportional to the square of the flow rate).

LINE VOLTAGE
1 115 volts, 50/60 Hz 2 230 volts, 50/60 Hz 3 24 VDC

RELAYS
B Two control relays

RESET BUTTON
- 0 None
- 2 Mounted on enclosure door

- N Standard instrument
- K Special instrument

| 675F | | | B | | | -- Product # Serial # ____________

SECTION 2 - SPECIFICATIONS

2.1 Operational

Display .... Two-line LCD, 7 digits per line, 3/8" high digits
1st line: Flow rate in GPM, liters per minute or other measurement units
2nd line: Total accumulated flow in gallons, liters or other measurement units

Ambient Conditions .... -30 to 50°C (-22 to 122°F), 0 to 100% relative humidity, non-condensing

Relay Function:

Setpoints.................... Selectable from 0-100% of measuring scale

Deadbands .... Selectable from 0-20% of measuring scale

Indicators .... LED lights when respective relay energizes

Outputs .... Two SPDT contact outputs, U.L. rating: 5A 115/230 VAC, 3A @ 30 VDC resistive

NOTE: Relays energize in response to increasing or decreasing flow rate, switch selectable.

Sensor-to-Analyzer Distance .... 2000 feet max. for GLI impeller sensor
300 feet max. for turbine flowmeter

Power Requirements..... 98-132 VAC, 50 or 60 Hz (less than 8 VA), optional 205-275 VAC, 50 or 60 Hz or 24 VDC (30 mA max.)

Inputs: Standard .... 0-2000 Hz from inductive pickup (turbine flowmeter)
0-200 Hz conditioned pulse signal from GLI impeller flow sensor
0-200 Hz from TTL-compatible flow signal source

Optional .... Transmitted, linear 4-20 mA (isolated) flow signal, 50 ohm input impedance

Square root extractor input for use with isolated 4-20 mA signal that is proportional to the square of the flow rate

Outputs: Analog (proportional to flow rate) .... 4-20 mA, 625 ohms maximum load
0-100 Hz, TTL or 24 VDC compatible
Re-transmitted flow input signal, LSTTL-compatible

Scalable.......... 24 VDC pulse, 30 mA maximum current
0.1 to 2.5 second pulse duration, user-selectable

2.2 Analyzer Performance (Electrical, Analog Outputs)

Sensitivity...................... 0.1% of span

Stability .... 0.1% of span per 24 hrs., non-cumulative

Non-linearity.................. 0.1% of span

Repeatability .... 0.1% of span or better

Temperature Drift.......... Zero: 0.02% of span per °C
Span: 0.01% of span per °C

Response Time .... 3 seconds to 90% of value on increasing flow rate;
2 seconds to 90% of value on decreasing flow rate

2.3 Mechanical

Enclosure .... NEMA 4X, 1/2 DIN, PVC with two 1/2-inch conduit holes and two stainless steel mounting brackets

Mounting Configurations .... Surface, panel and horizontal pipe mount. Vertical pipe mounting optional.

Net Weight .... 3 lbs. (1.36 kg)

PART TWO - INSTALLATION

SECTION 1 - UNPACKING

After unpacking, it is recommended to save the shipping carton and packing materials in case the instrument is stored or re-shipped. Inspect the equipment and carton for damage. If there is evidence of shipping damage, notify the carrier immediately.

SECTION 2 - MECHANICAL REQUIREMENTS

2.1 Location

1. Locate the 675F within 2000 feet of where the GLI impeller flow sensor is to be installed (300 feet for turbine flowmeter).
2. Mount the 675F in a location that is:
   - Clean and dry where little or no vibration exists.
   - Protected from falling corrosive fluids.
   - Within ambient temperature limits (-22 to 122°F, -30 to 50°C).

   CAUTION: MOUNTING IN DIRECT SUNLIGHT MAY INCREASE TEMPERATURE ABOVE MAX. LIMIT.

2.2 Mounting

Refer to Figure 2-1 for enclosure and mounting dimension details. Figure 2-2 illustrates various mounting configurations. Use the two stainless steel brackets provided to panel, surface or pipe-mount the instrument. The bracket attachment configuration determines the mounting method.

Inches (mm) Panel Cutout 5.43 in. (138 mm) square.

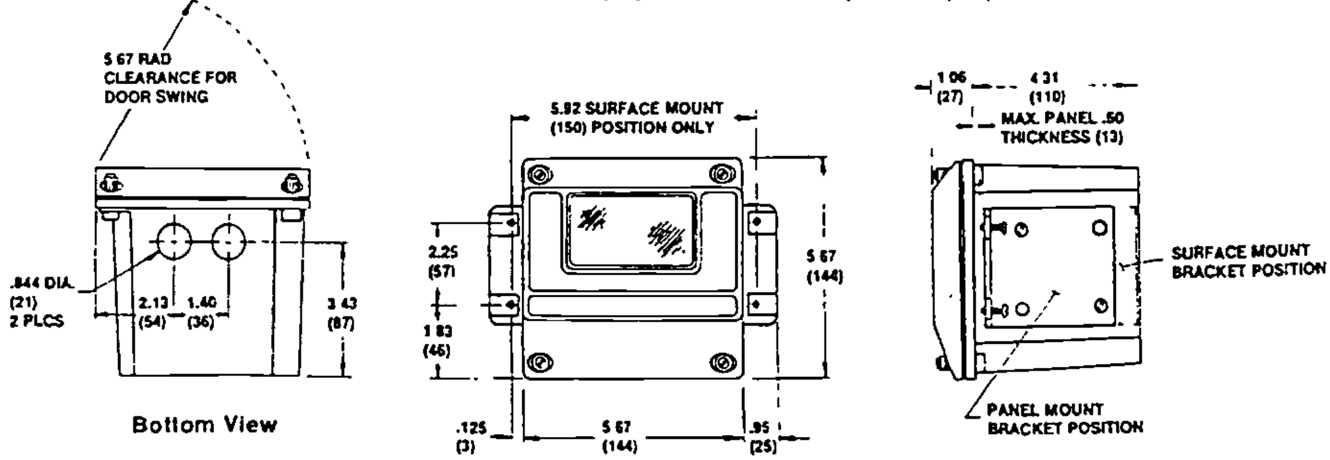


FIGURE 2-1 Enclosure Outline

685 31

To panel mount the instrument:

1. Place Tinnerman fasteners on each mounting bracket as shown in Figure 2-2.
2. Place instrument into square panel cutout (5.43 x 5.43", 138 x 138 mm) and fasten brackets to instrument case with No. 8-32 x 3/8" long screws.

   NOTE: Use appropriate mounting bracket holes (depicted in Figure 2-2 with screw heads) to properly position brackets.

3. Fasten No. 10-32 x 3/4" long screws into Tinnerman fasteners until ends of screws are snugged against panel.

2.3 Plugging Conduit Holes

Conduit hubs or cable feed-thru fittings should be used where cables enter the enclosure. Holes not used for cable entry should be sealed with plugs.

NOTE: Use NEMA 4 rated fittings and plugs to maintain the watertight integrity of the NEMA 4 enclosure. Generally, the left conduit hole (viewed from front) is used for power and relay wires; the right conduit hole for sensor input and instrument output wires.

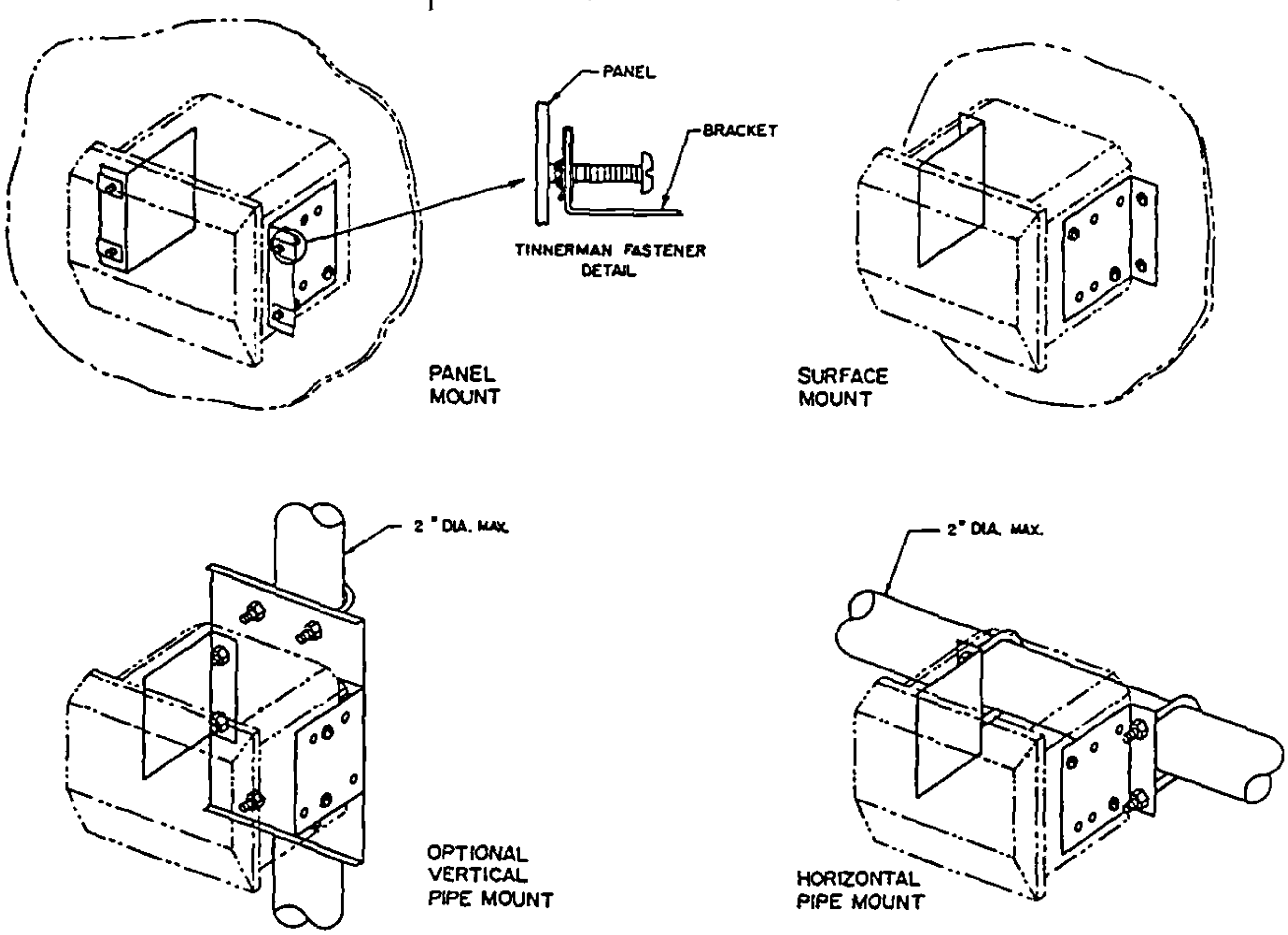


FIGURE 2-2 Mounting Configurations

SECTION 3 - ELECTRICAL CONNECTIONS

To access terminal strips for electrical connections, loosen four screws and open enclosure door. Carefully remove display module assembly (Figure 3-1, page 16) by loosening the two captive fasteners. Figure 3-2 on page 19 shows terminal designations for instrument hook-up.

3.1 Flow Input Signal

It is recommended that input signal wires be run in 1/2" metal conduit for protection against moisture and mechanical damage. Do not run input signal wires in same conduit with power or control wiring ("electrical noise" may interfere with input signal).

*NOTE: Make sure that **INPUT SELECT** switches, located behind the power supply board (Figure 3-2), are appropriately set to configure the 675F for the type of flow input signal used. Refer to Part Three, Section 2.2 for instructions.*

GLI Impeller Flow Sensor Or Turbine Flowmeter

Connect sensor (or interconnect cable) wires to SENSOR INPUT Terminals 1, 2 and 3 on TB2, matching colors as indicated. It is highly recommended to connect the sensor to the instrument with a junction box and interconnect cable. This wiring method makes electrical connections more convenient if the sensor is replaced or requires maintenance.

Transmitted 4-20 mA Flow Signal Input (Linear or Square Root)

When the 675F has the 4-20 mA input option, it can accept an isolated, linear 4-20 mA signal from a flow transmitter. When the 675F is equipped with the square root extractor input option, a 4-20 mA signal that is proportional to the square of the flow rate may be used. This type of signal is provided by an orifice plate flowmeter coupled with a differential pressure transducer.

The linear or square root 4-20 mA flow input signal can be connected in two ways:

1. When Transmitter Is Separately Powered

   Connect isolated 4-20 mA flow signal wires to SENSOR INPUT Terminals 1 and 2 on TB2, matching polarity as indicated.

2. When Model 675F Powers The Transmitter

   A. Connect signal's positive (+) wire to Terminal 7 on TB1.

   B. Connect signal's negative (–) wire to Terminal 1 on TB2.

NOTE: This wiring arrangement prevents use of RELAY C COIL terminals.

TTL-Compatible Input From Non-GLI Flowmeter

The 675F will accept a TTL-compatible flow input signal from a non-GLI flowmeter. Connect signal wires to AUX. INPUT Terminals 4 and 5 on TB2, matching polarity as indicated.

3.2 Remote Reset Input

When the 675F is specifically set up, the total accumulated flow may be reset from a remote location via a contact (switch) closure. Connect switch closure wires to RESET Terminal 13 and LO Terminal 14 on TB2. Refer to Part Three, Section 4.3 for remote reset operation setup instructions.

3.3 Analog Outputs

4-20 mA Output

This output represents the flow rate measuring scale and can drive a load of up to 625 ohms. Connect load to 4-20 mA Terminals 9 and 10 on TB2, matching polarity as indicated.

0-100 Hz Output (TTL or 24 VDC Compatible)

This output may be used in one of two ways:

1. To Drive a TTL-compatible Device

   Connect device "high" or (+) wire to Terminal 6 on TB2 and device "low" or (-) wire to LO Terminal 8 on TB2.

2. To Drive a Low-impedance, 24 VDC Device

   Connect device "high" or (+) wire to Terminal 7 on TB1 and device "low" or (-) wire to Terminal 6 on TB2.

   NOTE: This output cannot be used to drive a low impedance device if the scalable pulse output (RELAY C COIL terminals) is used. Output is current-limited to 60 mA maximum for this wiring arrangement.

Retransmission Of Flow Input Signal (LSTTL-compatible)

To drive an LSTTL-compatible device, connect device "high" or (+) wire to Terminal 7 on TB2 and device "low" or (-) wire to LO Terminal 8 on TB2.

3.4 Scalable Pulse Output

The 675F can generate a scalable, repetitive 24 VDC pulse output each time the total accumulated flow increases by a user-selected volume. The pulse output mode (on pulse or off pulse) and pulse duration is also user-selectable. Connect low-impedance device to RELAY C COIL Terminals 7 and 8 on TB1, matching polarity as indicated. Refer to Part Three, Section 5 for instructions to set up the scalable pulse output.

3.5 Relay Outputs

Two sets of SPDT relay outputs are provided at Terminals 1 through 6 on TB1. They are not powered. However, the instrument's line power may be used to power control or alarm devices via these relay contacts. Refer to Figure 2-3 for wiring details. An extra, unfused L1/HOT power source (Terminal 11 on TB1) is provided to connect line power to the relay outputs.

685 . 34

Always check control wiring to insure that line power will not be shorted by the switching action of the relay contacts. Refer to Part Three, Section 6 for relay setup instructions.

NOTE: Because of limited space within the instrument enclosure, it is recommended that bulky wiring connections (resulting from combinations of multiple connections per terminal and large gauge wires) be terminated outside the instrument enclosure, preferably in an external junction box.

CAUTION: Do not exceed each relay's contact rating of 3A 115/230 VAC. If larger currents are to be switched, use of an auxiliary relay will extend relay life. When relay outputs are used, the instrument's line power wiring must be adequate to conduct the anticipated load(s).

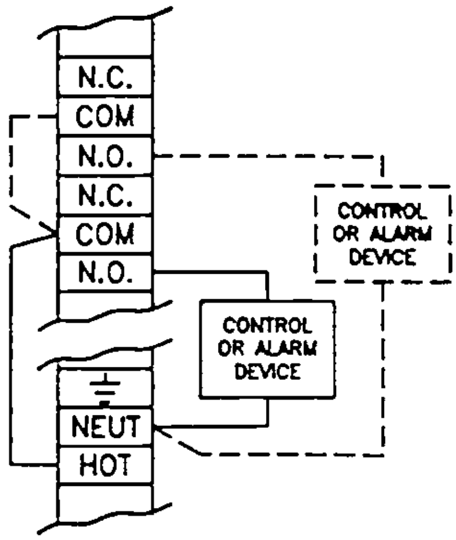


FIGURE 2-3 Connecting Control Or Alarm Device(s) To Relay Outputs

3.6 Line Power

Connect line power to MAINS Terminals 12, 13 and 14 on TB1 which are not fused. Use wiring practices which conform to local codes (National Electrical Code Handbook in the U.S.A.). Use only the standard three-wire connection. The ground terminal grounds the instrument which is mandatory for safe operation.

CAUTION: Any other wiring method may be unsafe or cause improper operation of the instrument.

It is recommended not to run line power or relay outputs powered off the line in the same conduit with input signal wires ("electrical noise" may interfere with input signal).

PART THREE - OPERATION

SECTION 1 - DESCRIPTION OF CONTROLS

Frequently used controls are located on front of the display board (Figure 3-1). They are accessed by opening the enclosure door which can be easily removed by unsnapping it from its hinge. Seldom used controls are located on the backside of the display module assembly (Figure 3-2). To access these controls, remove display module assembly from the instrument enclosure by loosening two captive fasteners.

WARNING: DO NOT ADJUST THE FACTORY-SEALED (RED SEALANT) POTENTIOMETERS. IF SEALS ARE BROKEN, THE INSTRUMENT WARRANTY IS VOIDED. IF THE INSTRUMENT IS RETURNED TO GLI AND ANY OF THE FACTORY-SEALED POTENTIOMETERS REQUIRES RE-ADJUSTMENT, A FACTORY SETUP CHARGE WILL BE INCURRED.

All switches, indicators and program jumpers used for instrument operation are described in this section. Familiarize yourself with each item before operating the instrument.

1.1 Pushbuttons

1. EXAM pushbutton (Figure 3-1)

   Selects the normal "measurement" mode or an "examination" display mode to indicate setup variables and their stored values. Successive key presses alternate the display between these two modes.

2. NEXT pushbutton (Figure 3-1)

   Scrolls display to show next setup variable with each press (in "examination" display mode only). Refer to Appendix 1 for a complete listing of all setup variables.

3. ↑ pushbutton (Figure 3-1)

   A. Increases the displayed value of a setup variable.

   B. Shifts displayed decimal point to the right for measuring scale setup.

4. ↓ pushbutton (Figure 3-1)

   A. Decreases the displayed value of a setup variable.

   B. Shifts displayed decimal point to the left for measuring scale setup.

5. **CHANGE** pushbutton (Figure 3-1)

   Displays "Change?" to ask if the stored setup variable value is to be changed to the displayed value. A second consecutive press enters displayed value into memory (if within acceptable range).

6. **RESET** pushbutton—optional (Figure 3-1)

   Resets displayed total accumulated flow to zero.

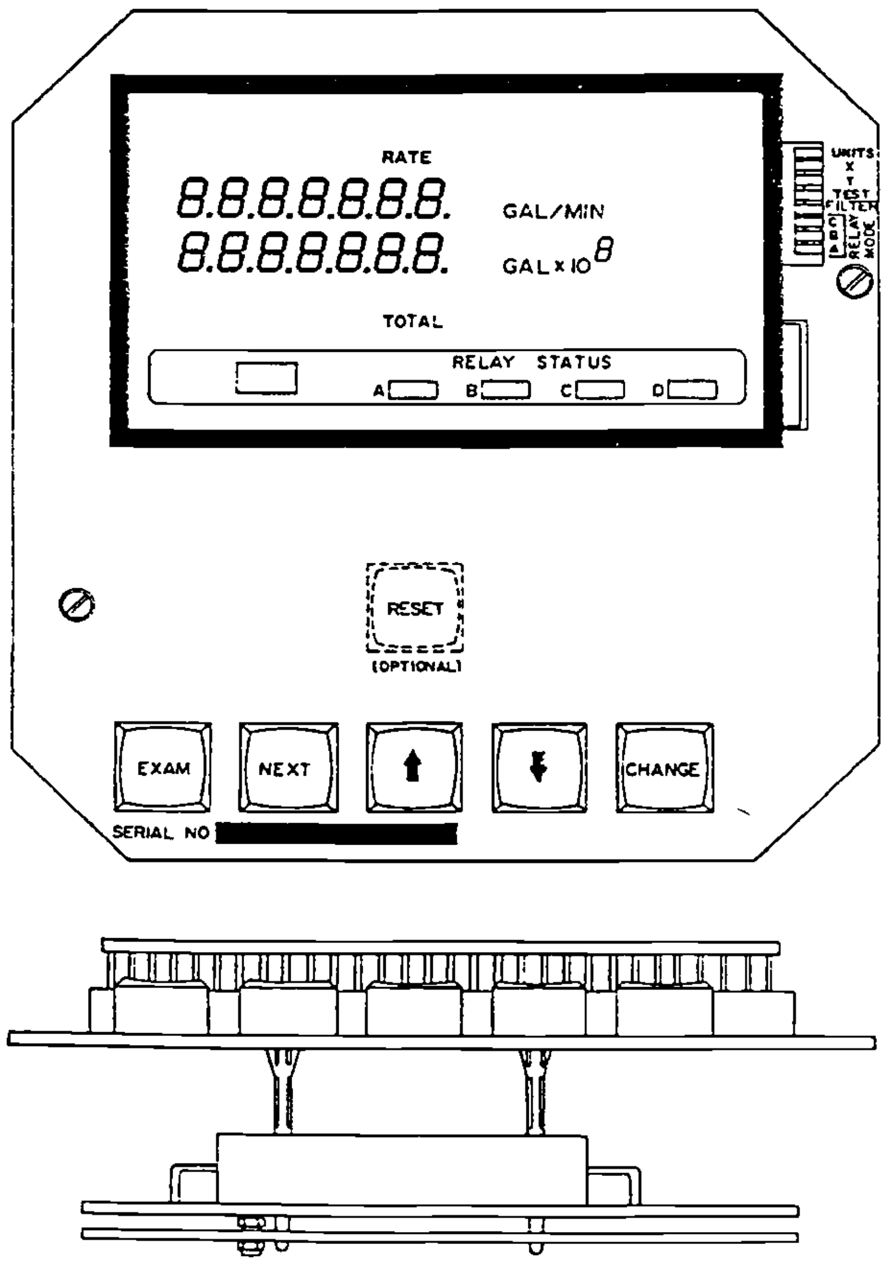


FIGURE 3-1 Controls On Front Of Display Module Assembly

1.2 Switches

7. **UNITS** switch (Figure 3-1)

UP POSITION - Displays flow rate in GAL/MIN on upper display line and total accumulated flow in GAL on lower display line.

DOWN POSITION - Displays flow rate in L/MIN (liters per minute) on upper display line and total accumulated flow in L (liters) on lower display line.

NOTE: This switch only selects the measurement units for display; it does not automatically convert the displayed value into an appropriate liter value. For units other than gallons or liters, cover the displayed units with a stick-on label that shows the desired measurement units.

8. **SWITCH "X"** and **SWITCH "Y"** (Figure 3-1)

These two switches set up the 675F for one of three modes to reset displayed total accumulated flow to zero. To select the desired reset mode, place switches in the positions shown in the following chart:

Reset Mode*	SWITCH "X"	SWITCH "Y"
Multiple Pushbutton Method	UP POSITION	UP POSITION
Remote (Switched Input) Method	DOWN POSITION	DOWN POSITION
Optional Reset Button Method	DOWN POSITION	DOWN POSITION

*See Part Three, Section 4.3 for details on all reset modes.

9. **TEST** switch (Figure 3-1)

DOWN POSITION (on) - Connects internally generated test signal to scaling section for diagnostic test of instrument circuits. Display should indicate about 50% of the flow rate measuring scale. Also, "test" flashes on the lower display line and the relays de-energize. The totalizer is disabled so that total accumulated flow is unaffected.

UP POSITION (off) - Disconnects internally generated test signal from scaling section and returns display to its "normal" indication mode and analog outputs to their actual values. The totalizer resumes counting the total accumulated flow.

685 38

10. **FILTER** switch (Figure 3-1)

    UP POSITION (off) - Selects a filter with a minimal amount of rate dampening. Use this switch position when quickest analyzer response to changing flow rate conditions is desired.

    DOWN POSITION (on) - Selects a dampened rate filter. Use this switch position when it is desired to average quickly changing measured flow rates in agitated pipe lines. It provides the most stable readings and instrument outputs under these conditions.

11. **RELAY C MODE** switch (Figure 3-1)

    UP POSITION - Selects "on" mode of operation for scalable pulse output; output turns *on* when total accumulated flow increases by a user-selected volume. When initiated, the pulse output remains *on* for a user-selected time and then turns *off*. This cycle repeats continuously.

    DOWN POSITION - Selects "off" mode of operation for scalable pulse output; output turns *off* when total accumulated flow increases by a user-selected volume. When initiated, the pulse output remains *off* for a user-selected time and then turns *on*. This cycle repeats continuously.

12. **RELAY A** and **B MODE** switches (Figure 3-1)

    UP POSITION - Selects low mode of operation for respective relay; relay turns on in response to *decreasing* flow rate.

    DOWN POSITION - Selects high mode of operation for respective relay; relay turns on in response to *increasing* flow rate.

685 ., 39

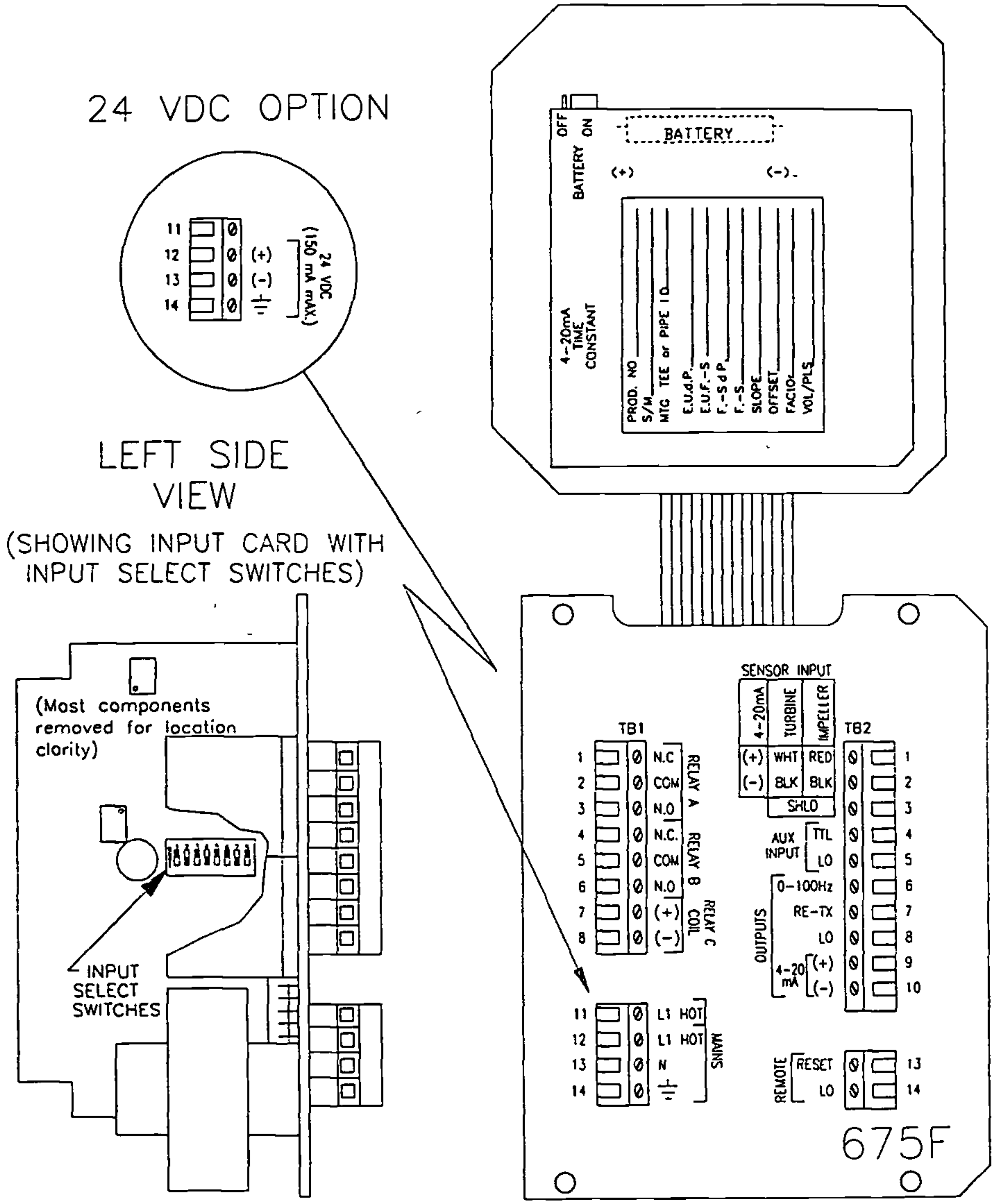


FIGURE 3-2 Controls On Backside Of Display Module Assembly And Electrical Hook-Up

685 40

13. **INPUT SELECT** switches (Figure 3-2)

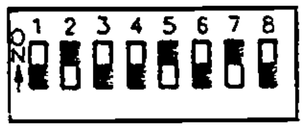
This group of eight slide switches configures the 675F for the type of flow signal source you're using.

NOTE: *When the 675F has the square root input option, these switches are deleted and the flow input signal need not be configured.*

The following arrangements illustrate the correct switch positions for the corresponding types of flow sensors:

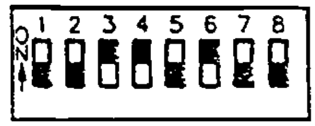
INPUT SELECT SWITCH ARRANGEMENTS

For GLI Impeller Flow Sensor



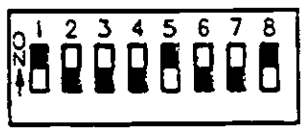
■ - Switch handle position.

For Any Turbine Flowmeter (0-2000 Hz)



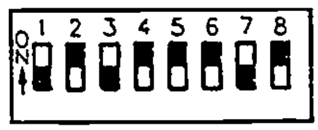
■ - Switch handle position.

For Transmitted, Linear 4-20 mA Flow Signal



■ - Switch handle position.

For TTL-Compatible Input From Non-GLI Flowmeter



■ - Switch handle position.

1.3 Controls

14. **4-20 mA TIME CONSTANT** control (Figure 3-2)

Adjusts the time it takes for the analog outputs to respond to a change in the input signal. Adjustment range is 0.5 to 3 seconds.

NOTE: *This "twenty-turn" potentiometer does not have mechanical stops at its adjustment endpoints. To adjust this control to an endpoint, slowly turn adjustment screw in one direction 20 complete turns or until a "soft clicking" sound is heard.*

1.4 Indicators

15. **RELAY STATUS** indicators (amber, Figure 3-1)

Lights whenever respective relay (A, B) turns on.

NOTE: *RELAY C status indicator flashes on for selected pulse duration to indicate scaleable pulse output is on. When "off" operating mode is selected, indicator flashes off to indicate output is off.*

1.5 Program Jumpers

16. **BATTERY** jumper (Figure 3-2)

    ON - Connects battery to store user-entered setup values and total accumulated flow even when power is lost or turned off.

    OFF - Disconnects battery when instrument is not in use for an extended time.

    CAUTION: Disconnecting the battery with line power removed will cause loss of all stored setup values and total accumulated flow.

SECTION 2 - CONFIGURING THE FLOW INPUT

2.1 Checking Battery Back-up Jumper

An internal battery retains all user-entered setup values in the event line power is lost. The instrument is supplied with the **BATTERY** jumper (Figure 3-2) in the **ON** position. Make sure jumper is **ON** before proceeding.

2.2 Setting INPUT SELECT Switches

(When the 675F has the square root input option, these switches are deleted and the flow input signal need not be configured.) These switches, located behind the power supply board (Figure 3-2), configure the 675F for the type of flow signal source being used. Find the **INPUT SELECT** switch arrangement on page 20 that corresponds to the input you're using and set switches to the positions shown.

NOTE: If a GLI impeller flow sensor was delivered with the 675F, these switches are factory-set and need not be changed.

2.3 Entering SLOPE, OFFSEt and UOL./PLS. Setup Values

A set of three setup variables called SLOPE, OFFSEt and UOL./PLS. (volume per pulse) calibrates the instrument to the specific flow signal source being used. The values entered for these setup variables define the delivered volume (in desired measurement units). Find the following appropriate subsection that corresponds to the flow signal source you're using for instructions to determine and enter the values for these setup variables.

Tee-Mounted GLI Impeller Flow Sensor

1. Refer to Appendix 2 to find your sensor model/mounting tee combination. The appropriate entry values for SLOPE, OFFSEt and UOL./PLS. are shown at the right of the table.
2. Write these values in the "Record Your Entry" column in Appendix 1 of this manual and on label on back of display board for handy reference.
3. Press **EXAM** button to place display in "examination" mode.

4. Press **NEXT** button until lower display line indicates "SLOPE".
5. Press ⬆ or ⬇ button to make upper display line indicate correct value for "SLOPE".
6. Press **CHANGE** button twice to enter value (lower display line indicates "SLOPE" to confirm entry).
7. Press **NEXT** button once (lower display line indicates "OFFSEt").
8. Press ⬆ or ⬇ button to make upper display line indicate correct value for "OFFSEt".
9. Press **CHANGE** button twice to enter value (lower display line indicates "OFFSEt" to confirm entry).
10. Press **NEXT** button twice (lower display line indicates "UOL./PLS.").
11. Press ⬆ or ⬇ button to make upper display line indicate correct value for "UOL./PLS.".
12. Press **CHANGE** button twice to enter value (lower display line indicates "UOL./PLS." to confirm entry).
13. Reset any displayed total accumulated flow to zero (Part Three, Section 4.3). The instrument is now calibrated for use with this sensor.

# # #

Direct Pipe-Mounted GLI Impeller Flow Sensor (mounted using insertion hardware, weldolet, etc. - not a pipe tee)

1. Refer to Appendix 3 for installations using Schedule 40 pipe or Appendix 4 for installations using Schedule 80 pipe. Find your pipe size and corresponding entry values for SLOPE, OFFSEt and UOL./PLS. in appropriate columns.

   If your pipe size is not listed, use the following procedure to obtain SLOPE, OFFSEt and UOL./PLS. values or contact the **GLI** Customer Service Department for assistance:

   A. Refer to Appendix 5 and use the formula to calculate the SLOPE value. The inside pipe diameter must be known. Note the calculated value.

   B. Refer to Appendix 6 and use the formula to calculate the OFFSEt value. Note the calculated value.

   C. Refer to Appendix 7 and, depending on whether your flow rate measurement units are or are not GAL/MIN, use the appropriate formula to calculate the UOL./PLS. value. Note the calculated value.

2. Write the SLOPE, OFFSEt and UOL./PLS. values in the "Record Your Entry" column in Appendix 1 of this manual and on label on back of display board for handy reference.

   NOTE: *If actual pipe inside diameter is greater than 20.000 inches, divide calculated SLOPE and OFFSEt values (but not the UOL./PLS. value) by "10" before writing them down and entering them into the instrument. To avoid entering wrong values, it is recommended to write down the original calculated values and the "divided-by-10" values.*

3. Refer to "Tee-Mounted GLI Impeller Flow Sensor" subsection and perform steps 3 through 13.

Turbine Flowmeter

A turbine flowmeter is typically provided with a certificate stating its "K" factor (pulses/gallon). This calibration data is determined by the manufacturer through product testing. Use the following procedure to obtain and enter the OFFSEt, SLOPE and UOL./PLS. values:

1. Determine the OFFSEt value. This value compensates for low flow rate sensor errors. It is assumed that the flow rate is zero GPM when the flowmeter input is 0 Hz. Therefore, the OFFSEt value is "0.0000".

   NOTE: *If the flow rate is not zero at 0 Hz., consult GLI.*

2. Use the following formula to determine the SLOPE value:

$$\boxed{SLOPE = \left(\frac{60}{K\ factor}\right) x\ (10)}$$

   NOTE: *The "K" factor must be in pulses/gallon.*

   Suppose the flowmeter "K" factor is 1200 (flowmeter provides 1200 pulses per gallon). Therefore:

$$SLOPE = \left(\frac{60}{1200}\right) x\ (10) \text{ or } 0.5000$$

NOTE: If calculated SLOPE value is less than "0.1000", multiply it by 10 and use this "SLOPE x 10" value.

Note the calculated value.

3. Determine the UOL./PLS. (volume per pulse) value. This value scales the display for total accumulated flow, but has no effect on the rate display. The totalizer display can be set to indicate any desired volume measurement units. Use the following formula to determine the UOL./PLS. value:

$$UOL./PLS. = \frac{SLOPE\ (from\ step\ 2)}{(60) \times (Conversion\ Factor)}$$

NOTE: If SLOPE happens to be a "SLOPE x 10" value, do not use this value in the formula. Instead, use the number before it was multiplied by ten.

Refer to Appendix 9 for typical volume conversion factors. Suppose the total accumulated flow is desired in barrels and the computed SLOPE is "0.5000". Therefore:

$$UOL./PLS. = \frac{0.5000}{(60) \times (31.5)} \text{ or } 0.0003$$

Note the calculated value.

4. Write the values for SLOPE, OFFSEt (always "0.0000") and UOL./PLS. in the "Record Your Entry" column in Appendix 1 of this manual and on label on back of display board for handy reference.

NOTE: If calculated SLOPE or UOL./PLS value is not within instrument's entry value range, contact GLI Customer Service Department for instructions.

5. Refer to "Tee-Mounted GLI Impeller Flow Sensor" subsection and perform steps 3 through 13.

Transmitted 4-20 mA Flow Signal Input (Linear or Square Root)

The isolated 4-20 mA signal can be linear to the flow rate or proportional to the square of the flow rate when the 675F is equipped with the linear 4-20 mA input option or the square root extractor input option respectively. In either case, use the following procedure to obtain and enter the OFFSEt, SLOPE and UOL./PLS. values:

1. Use the following formula to convert the full-scale flow rate (when the input signal is 20 mA) to U.S. gallons per minute:

$$\begin{matrix}\text{Full-scale Flow} \\ \text{(in GPM)}\end{matrix} = \begin{pmatrix}\text{Flow Rate} \\ \text{at 20 mA}\end{pmatrix} \times \begin{pmatrix}\text{Conversion} \\ \text{Factor}\end{pmatrix}$$

Some typical flow rate conversion factors are shown in Appendix 8. Suppose flow rate is known to be 8 liters/sec. at 20 mA (requires conv. factor of 15.85). Therefore:

$$\text{Full-scale Flow} = (8\ lps) \times (15.85) \text{ or } 126.8\ GPM$$

Note the calculated value.

2. Determine the OFFSEt value. This value compensates for low flow rate sensor errors. It is assumed that the flow rate is zero GPM when the sensor input is 4 mA. Therefore, the OFFSEt value is "0.0000".

   NOTE: If the flow rate is not zero at 4 mA, consult GLI.

3. Determine the SLOPE value using the following formula:

$$\boxed{SLOPE = \frac{\text{Full-scale Flow (from step 1)}}{100}}$$

Using the example in step 1, the calculated SLOPE would be:

$$SLOPE = \frac{126.8}{100} \text{ or } 1.2680$$

NOTE: If calculated SLOPE value is less than "0.1000", multiply it by 10 and use this "SLOPE x 10" value.

Note the calculated value.

4. Determine the UOL./PLS. (volume per pulse) value. This value scales the display for total accumulated flow, but has no effect on the rate display. The totalizer display can be set to indicate any desired volume measurement units. Use the following formula to determine the UOL./PLS. value:

$$\boxed{UOL./PLS. = \frac{\text{SLOPE (from step 3)}}{(60) \times \text{(Conversion Factor)}}}$$

NOTE: If SLOPE happens to be a "SLOPE x 10" value, do not use this value in the formula. Instead, use the number before it was multiplied by ten.

Refer to Appendix 9 for typical volume conversion factors. Suppose the total accumulated flow is desired in liters and the computed SLOPE is "1.2680". Therefore:

$$UOL./PLS = \frac{1.2680}{(60) \times (0.2642)} \text{ or } 0.0799$$

Note the calculated value.

5. Write the values for SLOPE, OFFSEt (always "0.0000") and UOL./PLS. in the "Record Your Entry" column in Appendix 1 of this manual and on label on back of display board for handy reference.

   NOTE: If calculated SLOPE or UOL./PLS. value is not within instrument's entry value range, contact GLI Customer Service Department for instructions.

6. Refer to "Tee-Mounted GLI Impeller Flow Sensor" subsection and perform steps 3 through 13.

TTL-Compatible Input From Non-GLI Flowmeter

The flowmeter frequency received by the 675F must be directly proportional to the flow rate and equal to or less than 200 Hz. Also, the full-scale flow rate and equivalent frequency must be known and the flow rate must be converted to U.S. GPM. Use the following procedure to obtain and enter the OFFSEt, SLOPE and UOL./PLS. values.

1. Determine the OFFSEt value. This value compensates for low flow rate sensor errors. It is assumed that the flow rate is zero GPM when the flowmeter input is 0 Hz. Therefore, the OFFSEt value is "0.0000".

   NOTE: If the flow rate is not zero at 0 Hz., consult GLI.

2. Determine the SLOPE value using the following formula:

$$SLOPE = \frac{\text{Full-scale Flow (in GPM)}}{\text{Full-scale Flow Equivalent Frequency}}$$

   For example, suppose the flowmeter provides a full-scale flow of 200 GPM at a frequency of 160 Hz. Therefore:

$$SLOPE = \frac{200}{160} \text{ or } 1.2500$$

   NOTE: If calculated SLOPE value is less than "0.1000", multiply it by 10 and use this "SLOPE x 10" value.

   Note the calculated value.

3. Determine the UOL./PLS. (volume per pulse) value. This value scales the display for total accumulated flow, but has no effect on the rate display. The totalizer display can be set to indicate any desired volume measurement units. Use the following formula to determine the UOL./PLS. value:

$$\text{UOL./PLS.} = \frac{\text{SLOPE (from step 2)}}{(60) \times \text{(Conversion Factor)}}$$

NOTE: If SLOPE happens to be a "SLOPE x 10" value, do not use this value in the formula. Instead, use the number before it was multiplied by ten.

Refer to Appendix 9 for typical volume conversion factors. Suppose the total accumulated flow is desired in Imperial gallons (Br., Can.) and the computed SLOPE is "1.2500". Therefore:

$$UOL./PLS. = \frac{1.2500}{(60) \times (1.2)} \text{ or } 0.0174$$

Note the calculated value.

4. Write the values for SLOPE, OFFSEt (always "0.0000") and UOL./PLS. in the "Record Your Entry" column in Appendix 1 of this manual and on label on back of display board for handy reference.

   NOTE: If calculated SLOPE or UOL./PLS. value is not within instrument's entry value range, contact GLI Customer Service Department for instructions.

5. Refer to "Tee-Mounted GLI Impeller Flow Sensor" subsection and perform steps 3 through 13.

SECTION 3 - SCALING THE FLOW RATE DISPLAY

Four setup variables called F.-S. (full-scale), F.-S.d.P. (full-scale decimal pt.), E.U.F.-S. (engineering unit full-scale) and E.U.d.P. (engineering unit decimal pt.) scale the flow rate display in any desired measurement units.

When flow rate is desired in GAL/MIN or L/MIN, locate the group of eight switches at upper right of display (Figure 3-1) and place **UNITS** switch in **UP POSITION** or **DOWN POSITION** respectively. For other measurement units, disregard the **UNITS** switch and cover the displayed unit annunciator with a stick-on label that shows the desired measurement units.

3.1 F.-S. and F.-S.d.P. Setup Values

These two setup variables are interlinked with each other and must be established together as a "matched" set.

Determining The Values

1. First, consider the F.-S. (full-scale) setup value. Use the following formula to determine the full-scale flow rate in U.S. gallons per minute:

$$\boxed{\begin{matrix}\text{Full-scale Flow} \\ \text{(in GPM)}\end{matrix} = \begin{pmatrix}\text{Full-scale Flow} \\ \text{In Desired Units}\end{pmatrix} \times \begin{pmatrix}\text{Conversion} \\ \text{Factor}\end{pmatrix}}$$

Some typical flow rate conversion factors are shown in Appendix 8. Suppose desired full-scale flow rate is to be 12 gal./sec. (requires conversion factor of 60). Therefore:

Full-scale Flow = (12 gps) x (60) or 720 GPM

Consider the full-scale GPM value as the F.-S. value unless:

A. The entered SLOPE value is a "divided-by-10" value (determined in Section 2.3, subsection "Direct Pipe-Mounted GLI Impeller Flow Sensor"). In this special case, divide the F.–S. value by 10 and use this "F.–S. divided-by-10" value.

B. The entered SLOPE value is a "SLOPE x 10" value (determined in Section 2.3, subsections "Turbine Flowmeter", "Transmitted 4-20 mA Flow Signal Input" or "TTL-Compatible Input From Non-GLI Flowmeter"). In this special case, multiply the F.–S. value by 10 and use this "F.–S. x 10" value.

2. Now select the F.-S.d.P. (full-scale decimal pt.) value to be applied to the F.-S. value being considered. The resolution can be set for "0.", "0.0" or "0.00". Choose the F.-S.d.P. value such that the resulting F.-S. value has the maximum number of "display counts" (disregarding the decimal pt.), but without exceeding 50,000 counts.

   For example, suppose the F.-S. value is 720 GPM as in step 1. If the F.-S.d.P. value was selected to be "0.", the resultant 720 display counts would be below the 50,000 count maximum but wouldn't be the maximum possible counts under the limit. If the F.-S.d.P. value was set for "0.00", the resultant 720.00 (or 72,000 display counts) would exceed the 50,000 count maximum. The correct F.-S.d.P. selection for this example is "0.0" which provides display resolution of 720.0 or 7,200 counts.

3. Write the F.-S.d.P. and F.-S. values in the "Record Your Entry" column in Appendix 1 of this manual and on label on back of display board for handy reference.

Entering The Values

1. Press **EXAM** button to place display in "examination" mode.
2. Press **NEXT** button until lower display line indicates "F.-S.d.P." (identifier for full-scale decimal pt. setup variable).
3. Press ⬆ or ⬇ button to shift decimal pt. right or left until upper display line indicates desired position.

4. Press **CHANGE** button twice to enter decimal point position (lower display line indicates "F.-S.d.P." to confirm entry).

5. Press **NEXT** button once to make lower display line indicate "F.-S." (identifier for full-scale setup variable).

6. Press ⬆ or ⬇ button to make upper display line indicate desired full-scale value.

7. Press **CHANGE** button twice to enter value (lower display line indicates "F.-S." to confirm entry).

3.2 E.U.F.-S. and E.U.d.P. Setup Values

Similar to the F.-S. and F.-S.d.P. setup variables discussed in Section 3.1, the E.U.F.-S. and E.U.d.P. setup variables are also interlinked with each other and must be established together as a "matched" set.

Determining The Values

1. First, consider the E.U.F.-S. (engineering unit full-scale) setup value. Although the instrument uses GPM values internally, the flow rate display can be scaled to indicate any desired measurement units. The E.U.F.-S. value should always be the value (in desired measurement units) that was multiplied by the conversion factor in the formula in Section 3.1, step 1 to calculate the full-scale flow value in GPM. For the example in Section 3.1, the E.U.F.-S. value would be 12 gallons/second.

2. Now select the E.U.d.P. (engineering unit decimal pt.) value to be applied to the E.U.F.-S. value being considered. It can be set from "0." to "0.000000" to provide the desired display resolution, but cannot exceed 50,000 display counts (disregarding the decimal pt.). For the 12 gallons/second example, any E.U.d.P. selection that would provide a resolution of no greater than "12.000" (or 12,000 counts) is acceptable. A selection which provides a display resolution of "12.0000" (or 120,000 display counts) would exceed the 50,000 count maximum.

3. Write the E.U.d.P. and E.U.F.-S. values in the "Record Your Entry" column in Appendix 1 of this manual and on label on back of display board for handy reference.

Entering The Values

1. Press **NEXT** button until lower display line indicates "E.U.d.P." (identifier for engineering unit decimal pt. setup variable).

2. Press ⬆ or ⬇ button to shift decimal pt. right or left until upper display line indicates desired position including zeros. To eliminate the decimal point entirely for measuring scales with whole numbers, press ⬇ button until zero

685 50

appears in extreme right position with no decimal point showing.

NOTE: Even under ideal circumstances, accuracy is no better than one part in 1000 (0.1%). Therefore, choosing a measuring scale which implies better resolution (20.000 for example) is for viewing convenience only.

3. Press **CHANGE** button twice to enter decimal point position (lower display line indicates "E.U.d.P." to confirm entry).
4. Press **NEXT** button once to make lower display line indicate "E.U.F.-S." (identifier for engineering unit full-scale setup variable).
5. Press ⬆ or ⬇ button to make upper display line indicate desired engineering unit full-scale value.
6. Press **CHANGE** button twice to enter engineering unit full-scale value (lower display line indicates "E.U.F.-S." to confirm entry).

SECTION 4 - TOTAL FLOW READOUT

4.1 Establishing Desired Volume Readout Units

The volume units for total accumulated flow need not be the same as the flow rate units. Whenever the accumulative total is desired in units other than U.S. gallons, an appropriate UOL./PLS. (volume per pulse) value must be entered to scale the instrument for those units. When a flow input other than from a GLI impeller sensor is used, the appropriate UOL./PLS. value has already been determined and entered in the procedure configuring the flow input (Part Three, Section 2.3). However, when configuring the flow input for a GLI impeller sensor, the UOL./PLS. values listed in the appendixes are for a total flow readout in U.S. gallons. To scale the readout in units other than U.S. gallons when using a GLI impeller flow sensor:

1. Calculate the appropriate UOL./PLS. value with the following formula:

$$\text{UOL./PLS} = \frac{\textit{Existing SLOPE Value}}{(60) \times (\textit{Conversion Factor})}$$

NOTE: If slope happens to be a "SLOPE x 10" value, do not use this value in the formula. Instead, use the number before it was multiplied by ten.

Suppose the existing SLOPE value is 8.4699 (for a GLI Model F1A11A1 impeller flow sensor in a 3" PVC mounting tee), the flow rate is in gallons/minute and the total accumulated flow is desired in barrels. The factor to convert U.S. gallons to barrels is 31.5 (from Appendix 9). Therefore:

$$\text{UOL./PLS.} = \frac{8.4699}{(60) \times (31.5)} \text{ or } 0.0044814$$

2. Round the value off to 4 places to the right of the decimal point (0.0045 for this example) and enter this UOL./PLS. value.

4.2 Entering A Multiplier Factor

To accomodate a very large total accumulated flow, the FACtOr setup variable may be used. It is an exponent for a "x10" multiplier annunciator which can be set from 0 (no multiplier) to 6 (10^6). For example, to totalize in kilogallons, a FACtOr value of 3 would be used (10^3 or 1000). A FACtOr of 6 would totalize in millions of gallons (10^6 or 1,000,000).

To enter a desired multiplier factor:

1. Press **EXAM** button to place display in "examination" mode.
2. Press NEXT button until lower display line indicates "FACtOr" (identifier for multiplier factor setup variable).
3. Press ⬆ or ⬇ button to make upper display line indicate desired exponent for the "x10" multiplier.

   NOTE: *If a multiplier factor is not required, use zero to delete "x10" multiplier from display.*

4. Press **CHANGE** button twice to enter exponent for multiplier factor (lower display line indicates "FACtOr" to confirm entry).

   NOTE: *Changing multiplier factor exponent for viewing convenience has no effect on instrument scaling.*

4.3 Resetting Total Accumulated Flow

The displayed total accumulated flow can be reset to zero using the multiple pushbutton method or remote (switch closure) method described below. When the optional reset button is provided, a third method to reset total flow may be used.

Multiple Pushbutton Method

1. Locate the group of eight switches at upper right of display (Figure 3-1) and write down the position that each switch is in. Then:

   A. Place **UNITS** switch in **DOWN POSITION.**

   B. Place **TEST** switch in **UP POSITION.**

685 52

2. Place instrument in the normal display indication mode (not "examination" mode).

3. Simultaneously press **CHANGE**, ↑ and **NEXT** buttons. The displayed total accumulated flow should now be reset to zero.

4. Place appropriate switches back to positions noted in step 1.

If a power interruption occurs, the displayed total accumulated flow at the time of the interruption is stored in the memory. Total accumulated flow counting and display resumes the moment power is restored. However, any flow past the sensor during the power outage will not be included in the displayed total.

Remote (Switch Closure) Method

1. Locate the group of eight switches at upper right of display (Figure 3-1) and place **SWITCH "X"** and **SWITCH "Y"** in the **DOWN POSITION**. The 675F is now configured so that it can be reset by a remote switch closure.

2. If not already done, connect the remote switch to RESET Terminal 13 and LO Terminal 14 on TB2.

3. To reset displayed total to zero, close remote switch.

*NOTE: To prevent unauthorized personnel from conveniently resetting the total with this method or the following optional reset button method, it is recommended to keep **SWITCH "X"** and **SWITCH "Y"** set in the **UP POSITION**. Then, when reset is required, reverse these two switch positions, reset the total and return them to the **UP POSITION**.*

Optional **RESET** Button Method

When the optional **RESET** button is mounted in the enclosure door, **SWITCH "X"** and **SWITCH "Y"** must be set in the **DOWN POSITION** to reset the total by pressing this button.

SECTION 5 - USING SCALABLE PULSE OUTPUT FEATURE

The 675F can generate a scalable, repetitive 24 VDC pulse output (RELAY C COIL Terminals 7 and 8 on TB1) every time the total accumulated flow increases by a user-selected volume. The duration of the pulse is also selectable. The pulse output can be configured for one of two operating modes. When the "on" mode of operation is selected, the output pulse turns on when the preselected volume is reached, remains on for the selected duration and then turns off. In the "off" mode, the opposite occurs. The output pulse turns off when the preselected volume is reached, remains off for the selected duration and then turns on. In either mode, the cycle repeats continuously.

The selected operating mode, volume and pulse duration must be determined by the operator based on specific application requirements. For reference, values entered into the instrument can be written in the "Record Your Entry" column in Appendix 1 of this manual. The procedure to set up the scalable pulse output feature is described with the following example:

> SCALABLE PULSE OUTPUT SETUP EXAMPLE
>
> Suppose the scalable pulse output is to turn on every time the total flow increases by 100 gallons and that the pulse duration is to be 1.2 seconds.

1. Locate the group of eight switches at upper right of display (Figure 3-1) and place **RELAY C MODE** switch in appropriate position. For this example, place in the **UP POSITION** ("on" mode). For applications that require the pulse output to turn off when the preselected volume is reached, place this switch in **DOWN POSITION** ("off" mode).
2. Press **EXAM** button to place display in "examination" mode.
3. Press **NEXT** button until lower display line indicates "St.Pt.C" identifier.
4. Press ⬆ or ⬇ button to make upper display line indicate desired volume setpoint value (100 GAL for this example).
5. Press **CHANGE** button once. The lower display line flashes "Change?" to ask if the value shown on upper line is to replace the currently-stored value.
   A. If yes, press **CHANGE** button again to enter new volume setpoint value (lower display line returns to "St.Pt.C" to confirm entry).
   B. If no, change displayed value until it's correct or press **EXAM** button to abort the routine (display returns to "normal" indication mode).
6. Press **NEXT** button until lower display line indicates "PLS.SEC." (identifier for pulse duration time).
7. Press ⬆ or ⬇ button to make upper display line indicate desired pulse duration in seconds (1.2 seconds for this example).

8. Press **CHANGE** button twice to enter new pulse duration time (lower display line returns to "PLS.SEC." to confirm entry).

SECTION 6 - RELAY SETUP

Two fully programmable SPDT relays are available for flow rate control and/or alarm purposes. Each relay (A, B) has an adjustable setpoint and deadband and a selectable operating mode. When the low mode of operation is selected, the relay will trip when the flow rate decreases below the setpoint. In the high mode, the relay will trip when the flow rate increases above the setpoint. LED's in the instrument display light to indicate that the relay is tripped.

The selected relay operating modes, setpoints and deadbands must be determined by the user based on specific application requirements. For reference, values entered into the instrument can be written in the "Record Your Entry" column in Appendix 1 of this manual. The procedure to set up a relay is described with the following example.

> RELAY SETUP EXAMPLE
>
> Suppose the flow rate measuring scale is 0-250 GAL/MIN and operational requirements for RELAY A are:
>
> RELAY A turns on at 195 GAL/MIN as the flow rate increases.
> RELAY A turns off at 180 GAL/MIN as the flow rate decreases below the setpoint value.

6.1 Selecting Relay Operating Modes

Locate the group of eight switches at upper right of display (Figure 3-1) and place respective relay mode switches in appropriate positions. For this example, place **RELAY A MODE** switch in **DOWN POSITION** (high mode). For applications that require the relay to trip in response to decreasing flow rate, place this switch in **UP POSITION** (low mode).

6.2 Entering Relay Setpoints

1. Press **EXAM** button to place display in "examination" mode.

2. Press **NEXT** button until lower display line indicates appropriate relay setpoint identifier (St.Pt.A for this example).

3. Press ⬆ or ⬇ button to make upper display line indicate desired setpoint value (195 GAL/MIN for this example).

   NOTE: If setpoint value exceeds 50,000, a "X10" multiplier factor must be applied before entering value.

Refer to Part Three, Section 4.2 for details.

4. Press **CHANGE** button once. The lower display line flashes "Change?" to ask if the value shown on upper line is to replace the currently-stored value.

   A. If yes, press **CHANGE** button again to enter new setpoint value (lower display line returns to appropriate relay setpoint identifier to confirm entry).

   B. If no, change displayed value until it's correct or press **EXAM** button to abort the routine (display returns to "normal" indication mode).

# # #

6.3 Entering Relay Deadbands

1. Press **NEXT** button until lower display line indicates appropriate relay deadband identifier (d.b.A for this example).
2. Press ↑ or ↓ button to make upper display line indicate desired deadband (195 minus 180 or 15 GAL/MIN for this example).
3. Press **CHANGE** button twice to enter new deadband value (lower display line returns to appropriate relay deadband identifier to confirm entry).

PART FOUR - OPERATING AIDS

SECTION 1 - PRESERVING MEASUREMENT ACCURACY

1.1 Keeping Sensor Clean

Clean the sensor as required using the recommended procedure described in the sensor operating instruction manual.

1.2 Reconfiguring Instrument When Changing Sensors

Whenever a different type of flow sensor replaces the type of sensor originally used, the instrument must be reconfigured for this new flow input signal. Use the procedure described in Part Three, Section 2. The instrument must also be reconfigured whenever a new turbine flowmeter replaces an existing turbine flowmeter even if it's the same size, since each flowmeter requires a unique set of SLOPE, OFFSEt and UOL./PLS. values.

1.3 Avoiding Electrical Interferences

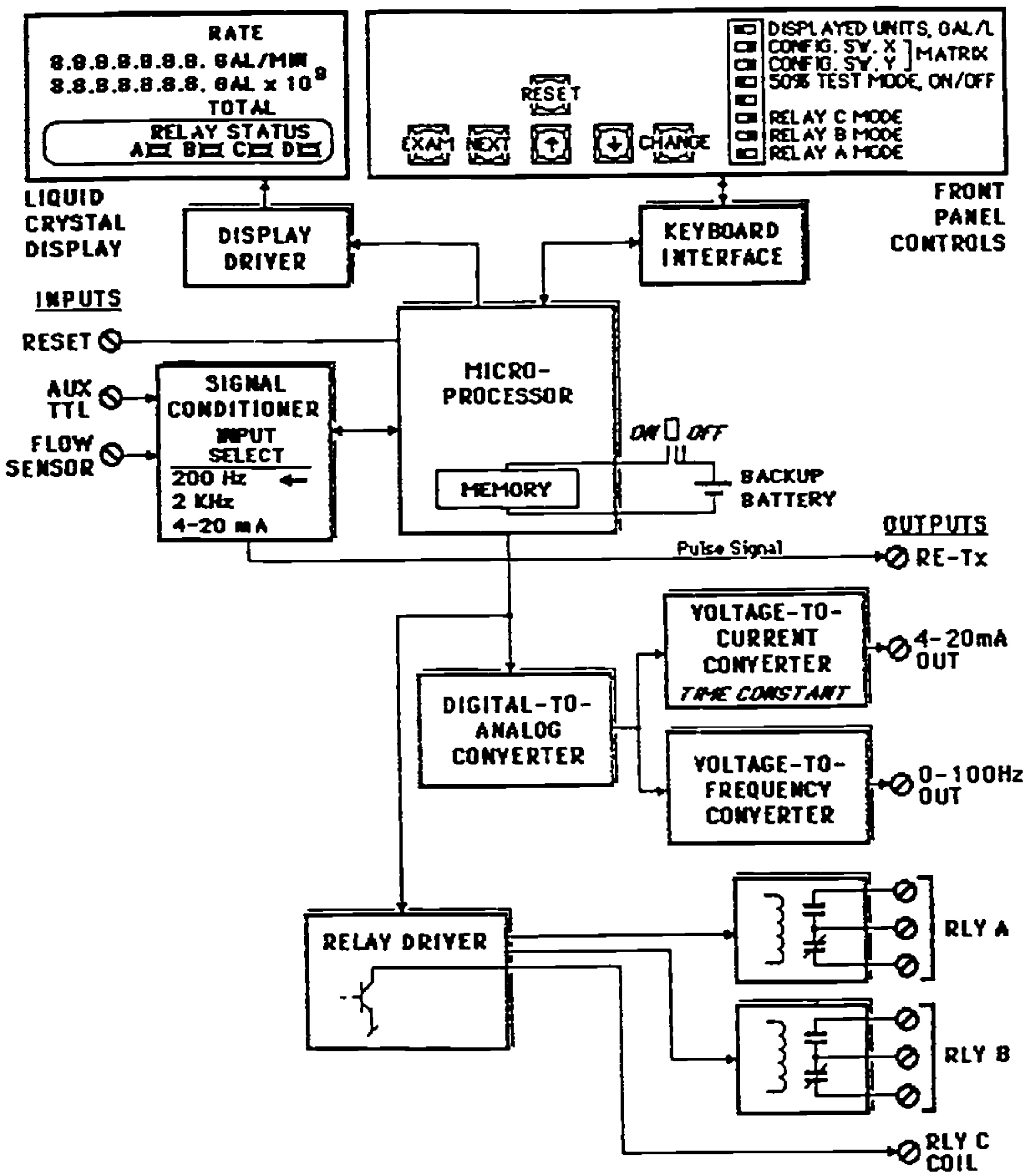
Do not run sensor wires in the same conduit with line power. Excess wire should not be coiled near motors or other equipment that may generate electric or magnetic fields. Cut wires to proper length during installation to avoid unnecessary inductive pick-up ("electrical noise" may interfere with sensor signal).

685 · 57

PART FIVE - PRINCIPLE OF OPERATION

See Figure 5-1 for functional diagram pertaining to these descriptions:

1. The power-supply section (not shown) converts line power to appropriate voltages for circuit operation. The voltages



Controls and jumpers are listed in *ITALICS*.

FIGURE 5-1 Instrument Operations Block Diagram power the flow sensor, the microprocessor and its associated circuitry.

2. The signal conditioner module accepts pulses from the flow sensor (or aux. input) and alters their magnitude for the microprocessor. The conditioned signal pulses are also sent to the Re-Tx (re-transmit) output so they can be used with other instrumentation. The frequency and duration of the pulses are not altered.

3. The microprocessor uses the conditioned flow signal pulses to calculate the flow rate. The processor also performs control algorithms, drives the display, monitors the pushbuttons and other configuration switches, and sends a digital signal to a converter that generates the analog outputs. The values for setup variables and totals are retained in memory that is powered from a trickle-charged backup battery.

4. The LCD display is driven by the microprocessor. It shows the flow related values along with annunciators that indicate the state of the instrument. LED's behind the display light to indicate the on/off status of each relay.

5. The pushbutton interface circuitry sends information to the microprocessor on the status of the user-operated pushbuttons and the four dip-switches that configure the instrument.

6. The microprocessor sends a digital signal to the digital-to-analog converter which produces an analog voltage representing the flow signal. The voltage from this converter is used by the voltage-to-current and voltage-to-frequency converters.

7. The voltage-to-current converter produces a 4-20 mA output from the analog flow signal. An adjustable control sets the time constant of the output. The 4-20 mA loop is powered by the instrument's power supply.

8. The voltage-to-frequency converter produces a 0-100 Hz. TTL-compatible pulse train from the analog voltage input. This output signal can be fed back into the input of the analyzer to test the circuitry in a "50% test" mode.

9. The microprocessor controls the relay driver circuitry. Those drive signals operate relays A and B.

PART SIX - SERVICE AND MAINTENANCE

SECTION 1 - GENERAL

1.1 Inspecting Sensor Cable

If a measurement problem exists and the sensor cable is suspected, inspect it for physical damage. If interconnect cable is used, disconnect cable at the sensor and instrument, and check wires for internal shorts or breaks (open circuit) with an ohmmeter.

1.2 Replacing Relays

1. *Disconnect line power.* Remove display module assembly by loosening two captive fasteners and disconnecting ribbon-cable connector located above TB2.
2. Unfasten screws that hold power-supply board to bottom of instrument case. Remove power-supply board.
3. Unsnap and remove black insulator (with terminal designations) to access relay pins.
4. Unsolder relay from backside of power-supply board (side opposite terminal strips).
5. Replace relay with equivalent relay (GLI p/n 99X2T1016). Solder relay pins into board and replace black insulator.
6. Mount power-supply board, connect ribbon-cable connector and install display module assembly with captive fasteners.

SECTION 2 - TROUBLESHOOTING

The measuring system typically consists of three elements: the sensor, interconnect cable and Model 675F. The procedure in this section is intended to isolate the problem to a particular element of the system. If the conditions for each step of this procedure are met, the system is verified to be operating properly.

2.1 Checking The Sensor

Refer to sensor (or Model 705 flow tester) operating instruction manual for details to determine if sensor is defective or operating properly. After verifying sensor operation, proceed with Section 2.2.

2.2 Checking The Interconnect Cable

Verify that sensor hookup is correct and that wires are terminated properly to make positive connection. Check cable for physical damage. After verifying that interconnect cable is okay, proceed with Section 2.3.

2.3 Checking The Instrument

Locate the group of eight switches at upper right of display (Figure 3-1) and place **TEST** switch in **DOWN POSITION**. The display should indicate about 50% of the full-scale value of the flow rate measuring scale. If not, the instrument may be defective. Call the GLI Customer Service Department for assistance.

2.4 Stabilizing Erratic Flow Rate Display and Outputs

In some flow measurement applications, the flow rate can fluctuate rapidly causing the instrument display and outputs to be erratic. By placing the **FILTER** switch, located in the group of eight switches at upper right of display (Figure 3-1), in the **DOWN POSITION** (on) a dampened rate filter is applied to average (smooth out) the flow rate display and outputs.

2.5 Customer Assistance

Should service, parts or assistance in troubleshooting or repair be required, please contact your GLI representative or the GLI Customer Service Department:

Great Lakes Instruments, Inc.
9020 West Dean Road
Milwaukee, Wisconsin 53224

Telephone: 414/355-3601
Telefax: 414/355-8346

— SERVICE HOURS —

	Eastern Std. Time	Central Std. Time	Mountain Std. Time	Pacific Std. Time
Monday through Thursday	8:30 a.m. to 5:30 p.m.	7:30 a.m. to 4:30 p.m.	6:30 a.m. to 3:30 p.m.	5:30 a.m. to 2:30 p.m.
Friday	8:30 a.m. to 4:00 p.m.	7:30 a.m. to 3:00 p.m.	6:30 a.m. to 2:00 p.m.	5:30 a.m. to 1:00 p.m.

When ordering spare or replacement board assemblies, be sure to use the **complete** assembly part number.

All board assemblies or instruments returned for repair, freight prepaid, should also include the following information:

1. A clearly written description of the malfunction.
2. Name of person to contact and the phone number where they can be reached.
3. Proper return address for shipping instrument(s) back. Include preferred shipping method (UPS, Federal Express, etc.) if applicable.
4. A purchase order if instrument(s) or board assemblies are out of warranty to cover costs of repair.

NOTE: If the instrument or board assemblies are damaged during return shipment as a result of inadequate packaging, the customer assumes responsibility for repair *costs. It is recommended to use the original GLI shipping carton or an equivalent. Also, GLI will not accept instruments returned for repair or replacement unless they are thoroughly cleaned and all process material is removed.*

PART SEVEN - SPARE PARTS AND ACCESSORIES

Description	Part Number
Program Jumpers (7 per package)	670X4A1140
Relay (5A Contacts, 24 VDC Coil)	99X2T1016
Power-Supply Board Assembly* (No 4-20 mA input option— 115 V, 50/60 Hz)	675M4G2270-101
Power-Supply Board Assembly* (No 4-20 mA input option— 230 V, 50/60 Hz)	675M4G2270-102
Power-Supply Board Assembly* (With linear 4-20 mA input option— 115 V, 50/60 Hz)	675M4G2270-103
Power-Supply Board Assembly* (With linear 4-20 mA input option— 230 V, 50/60 Hz)	675M4G2270-104
Power-Supply Board Assemby* (With square root extractor input option—115 V, 50/60 Hz)	675M4G2270-105
Power-Supply Board Assembly* (With square root extractor input option— 230 V, 50/60 Hz)	675M4G2270-106
Display Module Assembly (No Reset Button—3 boards including LCD, specify measuring scale)	675M4G2250
Display Module Assembly (With Optional Reset Button— 3 boards including LCD, specify measuring scale)	675M4G2290
Optional Vertical Pipe-mount Kit	1000A4A1077
Door Assembly (No Reset Button)	675M4G2260
Door Assembly With Optional Reset Button	675M4G2280

*Power-supply board assembly includes appropriately marked terminal block insulator.

Description of Setup Variables

Setup Variable		Entry Value Range		Default Value	Record Your Entry
Displayed Identifier	Use	Minimum	Maximum		
St.Pt. A St.Pt. b St.Pt. C	Relay A Setpoint Relay B Setpoint Pulse Output Volume Setpoint	0* 0* 0*	50,000* 50,000* 50,000*	50,000. 50,000. 50,000.	
d.b.A d.b.b.	Relay A Deadband Relay B Deadband	1* 1*	10,000* 10,000*	100. 100.	
PLS.SEC.	Pulse Duration (in seconds, for pulse output feature)	0.1	2.5	1.0	
E.U.d.P.	Engineering Units Decimal Point (for display scale set-up)	0. (max.) 0.0 0.00 0.000 0.0000 0.00000 0.000000 0 (min.)		0.	
E.U.F.-S.	Engineering Units Full-scale Value (for display scale set-up)	100*	50,000*	1000.	
F.-S.d.P.	Full-scale Decimal Point (for setting measurement units)	0. (max.) 0.0 0.00 (min.)		0.	
F.-S.	Full-scale Value (for setting measurement units)	100*	50,000*	1000.	
SLOPE	Slope (for calibration)	0.1000	327.6675	10.0000	
OFFSEt	Offset (for calibration)	0.0000	999.9999	0.0000	
FACtOr	Multiplier Factor (for displayed total)	0	7	0	
UOL./PLS.	Volume per Pulse (for calibration)	0.0001	999.9999	0.1670	

*These listed minimum and maximum entry values are determined and limited by the stored E.U.d.P. entry. Changing the E.U.d.P. entry will change this set of entry value ranges by factors of ten.

Appendix 2

Calibration Values For Tee-Mounted GLI Impeller Flow Sensors

Sensor Model	Mounting Tee Being Used			Linear GPM Range		Minimum Full Scale GPM	Calibration Values		
	Size	Model No.	Material	Min.	Max.		SLOPE (GPM/Hz)	OFFSEt (GPM)	UOL/PLS* (Gal/Pls)
F1A11A1 (polyprop)	1/2"	MHF13J1	cast bronze	1	35	3	0.2646	0.0000	0.0044
		MHF15J2	PVC	1	35	3	0.2658	0.0222	0.0044
	3/4"	MHF13K1	cast bronze	1	35	3	0.2778	0.0564	0.0047
		MHF15K2	PVC	1	35	3	0.2749	0.0194	0.0046
	1"	MHF13B1	cast bronze	2	65	7	0.6897	0.0000	0.0115
		MHF15B2	PVC	1	35	3	0.2731	0.0000	0.0046
		MHF15L2	PVC	3	65	7	0.6803	0.6487	0.0114
	1-1/4"	MHF13C1	cast bronze	3	90	8	0.7036	0.6735	0.0117
	1-1/2"	MHF13D1	cast bronze	4	125	10	1.0135	0.1712	0.0169
		MHF15D2	PVC	6	190	16	1.5290	0.8864	0.0255
	2"	MHF15E2	PVC	12	380	32	3.0330	1.5598	0.0506
	3"	MHF15G2	PVC	25	870	70	6.9724	0.3937	0.1162
	4"	MHF15H2	PVC	47	1635	132	13.0538	1.2252	0.2176
F1A11B2 (PVDF)	1/2"	MHF13J1	cast bronze	1	35	3	0.2848	0.0000	0.0048
		MHF15J2	PVC	1	35	3	0.2841	0.0000	0.0047
	3/4"	MHF13K1	cast bronze	1	35	3	0.2955	0.0000	0.0049
		MHF15K2	PVC	1	35	3	0.2902	0.0236	0.0048
	1"	MHF13B1	cast bronze	2	65	6	0.6471	0.0000	0.0108
		MHF15B2	PVC	1	35	3	0.2922	0.0000	0.0049
		MHF15L2	PVC	3	65	7	0.6328	0.4515	0.0105
	1-1/4"	MHF13C1	cast bronze	3	90	7	0.7118	0.1743	0.0119
	1-1/2"	MHF13D1	cast bronze	4	125	10	1.0147	0.0093	0.0169
		MHF15D2	PVC	6	190	16	1.4902	1.0872	0.0248
		MHF16D2	PVDF	11	380	30	3.0306	0.0000	0.0505
	2"	MHF15E2	PVC	13	350	31	2.7733	3.4062	0.0462
		MHF16E2	PVDF	13	410	34	3.2523	1.3985	0.0542
	3"	MHF15G2	PVC	27	875	73	6.9753	2.9836	0.1163
		MHF16G2	PVDF	29	950	78	7.5742	2.2779	0.1263
	4"	MHF15H2	PVC	48	1645	133	13.1287	2.0528	0.2188
		MHF16H2	PVDF	51	1585	133	12.6257	6.6730	0.2104
F1A12C1 (stainless) -or- F1A12D1 (brass)	2"	MHF12E1	brass	8	285	23	2.2623	0.0000	0.0377
		MHF14E1	cast iron	8	285	23	2.2935	0.0000	0.0382
	2-1/2"	MHF12F1	brass	11	375	30	3.0167	0.0000	0.0503
		MHF14F1	cast iron	11	390	31	3.1146	0.0000	0.0519

*For U.S. Gallons

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Calibration Values For Direct Pipe-Mounted** GLI Impeller Flow Sensors - Schedule 40 Pipe

Nominal Pipe Size	Pipe I.D. (inches)	Linear GPM Range		Minimum Full Scale GPM	Calibration Values		
		Min.	Max.		SLOPE (GPM/Hz)	OFFSEt (GPM)	UOL/PLS* (Gal/Pls)
3 inch	3.068	14	503	40	4.0249	0.0135	0.0671
4 inch	4.026	29	1008	81	8.0604	0.4821	0.1343
5 inch	5.047	50	1725	140	13.7867	1.7158	0.2298
6 inch	6.065	77	2624	213	20.9605	3.7002	0.3493
8 inch	7.981	144	4813	394	38.4283	9.4779	0.6405
10 inch	10.020	238	7857	646	62.7066	18.5571	1.0451
12 inch	11.938	348	11392	939	90.8984	29.8556	1.5150
14 inch	13.124	431	13982	1156	111.5293	40.9880	1.8588
16 inch	15.000	583	18644	1549	148.6492	62.7173	2.4775
18 inch	16.876	759	23996	2002	191.2493	89.4100	3.1875
20 inch	18.812	966	30242	2532	240.9578	122.1605	4.0160
24 inch	22.624	1448	44689	3761	355.8937	202.0972	5.9316

*For U.S. Gallons
**Sensor is mounted using insertion hardware, weldolet, etc. - not a pipe tee.

Appendix 4

Calibration Values For Direct Pipe-Mounted** GLI Impeller Flow Sensors - Schedule 80 Pipe

Nominal Pipe Size	Pipe I.D. (inches)	Linear GPM Range		Minimum Full Scale GPM	Calibration Values		
		Min.	Max.		SLOPE (GPM/Hz)	OFFSEt (GPM)	UOL/PLS* (Gal/Pls)
3 inch	2.900	12	431	35	3.4506	0.0001	0.0575
4 inch	3.826	25	889	71	7.1109	0.3292	0.1185
5 inch	4.813	45	1544	125	12.3444	1.3662	0.2057
6 inch	5.761	68	2336	190	18.6651	3.0287	0.3111
8 inch	7.625	130	4357	356	34.7910	8.2026	0.5798
10 inch	9.562	215	7109	584	56.7424	16.2546	0.9457
12 inch	11.374	313	10285	847	82.0697	26.2557	1.3678
14 inch	12.500	386	12584	1039	100.3969	34.8603	1.6733
16 inch	14.312	525	16854	1398	134.3996	54.1720	2.2400
18 inch	16.124	685	21767	1813	173.5148	78.1141	2.8919
20 inch	17.938	869	27331	2285	217.7944	106.7209	3.6299
24 inch	21.562	1303	40378	3394	321.5994	177.7680	5.3600

*For U.S. Gallons
**Sensor is mounted using insertion hardware, weldolet, etc. - not a pipe tee.

685 66

Appendix 5▲

Formulas To Calculate SLOPE Value
When Known Pipe I.D. Is Not Shown in Appendix 3 or 4

For I.D.'s from 2.90 to 11.96 inches: SLOPE = (I.D.^{2} x 0.7055) + (-0.7922 x I.D.) + (-0.1850)

For I.D.'s from 11.97 to 40.00 inches: SLOPE = (I.D.^{2} x 0.7786) + (-2.1098 x I.D.) + (5.1172)

Appendix 6▲

Formulas To Calculate OFFSEt Value
When Known Pipe I.D. Is Not Shown in Appendix 3 or 4

For I.D.'s from 2.90 to 11.96 inches: OFFSET = (I.D.^{2} x 0.3634) + (-2.0888 x I.D.) + (3.0014)

For I.D.'s from 11.97 to 40.00 inches: OFFSET = (I.D.^{2} x 0.7052) + (-8.2488 x I.D.) + (27.7910)

▲ *Notes For Appendixes 5 and 6:*

1. *Pipe I.D. must be in inches.*
2. *If actual pipe inside diameter is greater than 20.000 inches, divide calculated F.-S., SLOPE and OFFSEt values (but not the UOL./PLS. value) by "10" before writing them down and entering them into the instrument. To avoid entering wrong values, it is recommended to write down the original calculated values and the "divided-by-10" values.*

Appendix 7

Formulas To Calculate UOL./PLS. Value
When Known Pipe I.D. Is Not Shown in Appendix 3 or 4

If Display Scale Measurement Units Are:	Formula To Use
GAL/MIN	UOL./PLS. = $\frac{\text{SLOPE*}}{60}$
Not GAL/MIN	UOL./PLS = $\frac{\text{SLOPE*}}{\text{(60xConversion Factor**)}}$

*Calculated by using actual pipe inside diameter and formula in Appendix 5.

**Refer to Appendix 9 and use the conversion factor that corresponds with the display scale measurement units. If not listed, determine the correct conversion factor to use.

Appendix 8

Typical Flow Rate Conversion Factors

Desired Flow Rate Units	U.S. GAL/MIN Conversion Factor
Cu.ft./second (c.f.s) Cu.ft./minute (c.f.m.) Cu.ft./hour (c.f.h.)	448.8 7.481 0.125
Cu.meter/second (c.m.s) Cu.meter/minute (c.m.m.) Cu.meter/hour (c.m.h.)	15,852 264.2 4.403
Liter/second (l.p.s.) Liter/minute (l.p.m.) Liter/hour (l.p.h.)	15.8508 0.2642 0.004403
Barrel/second (b.p.s.) Barrel/minute (b.p.m.) Barrel/hour (b.p.h.)	1890 31.5 0.525
U.S. Gallon/second (g.p.s.) U.S. Gallon/minute (g.p.m.) U.S. Gallon/hour (g.p.h.) U.S. Gallons/day	60 1 0.016667 0.0006944
Million Gallons/day (MGD) Million Liters/day Megaliters/day	694.44 183.47 183.47
Imperial Gallons/second Imperial Gallons/minute Imperial Gallons/hour Imperial Gallons/day	72.054 1.2009 0.02001 0.0008338
Acre Foot/day Acre Inch/hour	226.3 452.6

<u>Example</u>

Barrel/minute x 31.5 = GAL/MIN

Appendix 9

Typical Volume Conversion Factors

Desired Volume Units	U.S. Gallon Conversion Factor
Fluid ounces Pints Quarts	0.0078125 0.125 0.25
Imperial gallons (Br., Can.) U.S. gallons Liters Barrels (liquid) Barrels (oil)	1.2009 1 0.2642 31.5 42
Cubic inches Cubic feet Cubic meters	0.00433 7.481 264.17
Acre-feet Acre-inches	325,851 27,154

<u>Example</u>

Imperial gallons x 1.2009 = U.S. gallons

Technology For Solutions

GLI International

Data Sheet 675F/1197
Supersedes 675F/896

Model 675F
Digital Flow Monitor/Totalizer

Certified by CSA for General Purpose use.

- **Two Measurement Readouts.** The Model 675F microprocessor-based monitor/totalizer features a digital LCD that simultaneously displays the measured flow rate (upper readout) and the total accumulated flow (lower readout).

- **Control and Alarm Capability.** Two SPDT relays can be independently set to operate in response to increasing or decreasing flow rate.

- **Standard Multiple Outputs.** The Model 675F provides three analog outputs: 4-20 mA, 0-100 Hz., and a retransmitted flow input signal that is LSTTL-compatible. Additionally, the instrument has a scaleable pulse output to provide one 24 VDC pulse each time the total accumulated flow increases by a user-set volume. The duration of the pulse is adjustable from 0.1 to 2.5 seconds.

- **Simple Pushbutton Operation.** Menu-driven operation makes the Model 675F simple to use. Five pushbuttons (located behind the enclosure door) configure the instrument and conveniently recall stored setup values.

- **Versatile Input Capability.** The Model 675F can be used with most brands of flow sensors. It accepts these types of input signals:
  - Isolated 4-20 mA
  - 0-2000 Hz. (typical of most turbine flow sensors)
  - 0-200 Hz. (provided by all GLI impeller flow sensors)
  - TTL-compatible 0-200 Hz.

- **Resettable Total Accumulated Flow.** The accumulated flow total can be reset using a specific pushbutton sequence, or a switched input signal from a remote location.

- **NEMA 4X Protection.** The NEMA 4X enclosure protects the instrument circuitry from harsh environments. Also, the hinged cover is easily removed to facilitate installation and servicing.

- **Universal Mounting.** Two stainless steel brackets enable the monitor/totalizer to be surface, panel or horizontal pipe mounted. Vertical pipe mounting requires optional hardware

FLOW

Specifications

Operational:

Display .... Two-line LCD with 7 digits per line; 3/8 inch (9.5 mm) high digits;
1st line: Shows flow rate in GPM, liters per minute, or other measurement units
2nd line: Shows total accumulated flow in U.S. gallons, liters, or other measurement units

Ambient Conditions .... -22 to 122°F (-30 to 50°C), 0-100% relative humidity, non-condensing

Relay Function
- Setpoints .... Selectable, 0-100% of measuring scale
- Deadbands .... Selectable, 0-20% of measuring scale span
- Indicators .... LED lights when respective relay is on
- Outputs .... Two SPDT contact outputs, U.L. rating: 5A 115/250 VAC, 5A @ 30 VDC resistive

NOTE: *Relays can be switch selected to operate in response to increasing or decreasing flow rate.*

Sensor-to-Analyzer Distance .... GLI impeller flow sensors: 2000 ft. (610 m) maximum
Turbine flow sensors. 300 ft. (91 m) maximum

Power Requirements .... 98-137 VAC, 50/60 Hz. (less than 8 VA);
optional 195-275 VAC, 50/60 Hz. - or - 24 VDC (150 mA max.)

Signal Inputs
- Standard .... 0-2000 Hz from inductive pickup (turbine flow sensors)
0-200 Hz. conditioned pulse signal (GLI impeller flow sensors)
0-200 Hz. from TTL-compatible flow signal source
- Optional .... Transmitted, linear 4-20 mA (isolated) flow signal; 50 ohm input impedance

Outputs:
- Analog .... 4-20 mA, 625 ohms maximum load
0-100 Hz., TTL or 24 VDC compatible
Retransmitted flow input signal, LSTTL-compatible
- Scaleable Pulse .... 24 VDC pulse (30 mA max.) occurs each time total accumulated flow increases by user-set volume; adjustable pulse duration of 0.1 to 2.5 seconds

Electrical Certification (optional) .... CSA: General Purpose

Analyzer Performance
(Electrical, Analog Outputs):

- Sensitivity .... 0.1% of span
- Stability .... 0.1% of span per 24 hours, non-cumulative
- Non-linearity .... 0.1% of span
- Repeatability .... 0.1% of span or better
- Temperature Drift .... Zero: 0.02% of span per °C;
Span: 0.01% of span per °C
- Response Time .... 3 seconds to 90% of value on increasing flow rate;
2 seconds to 90% of value on decreasing flow rate

Mechanical:

- Enclosure .... NEMA 4X, 1/2 DIN, polycarbonate case with two 1/2-inch conduit holes and two stainless steel mounting brackets
- Mounting Configurations .... Surface, panel, and horizontal pipe mount; vertical pipe mounting requires optional hardware
- Net Weight .... 3 lbs. (1.36 kg) approximately

Ordering Information

MODEL NUMBER
675F Microprocessor-based monitor/totalizer in NEMA 4X, 1/2 DIN enclosure with stainless steel mounting brackets for panel, surface and horizontal pipe mounting.

INPUT CAPABILITY
3C Accepts 0-2000 Hz (turbine), 0-200 Hz. (GLI impeller), and 0-200 Hz. from TTL-compatible source
4C Same as 3C above, plus accepts transmitted, linear 4-20 mA (isolated) flow signal

LINE VOLTAGE
1 115 volts, 50/60 Hz.
2 230 volts, 50/60 Hz.
3 24 VDC

RELAYS
B0 Two control relays

EQUIPMENT TAGGING (specify tag data)
N None
P Paper
S Stainless steel

AGENCY CERTIFICATION
N None
C CSA Certified (safe area use only)

675F			B0		

Product Number (see Notes below)

Choose one from each category.

NOTES: When ordering, please provide the following information.

1. When Model 675F is used with.
   - A GLI Flow Sensor· The sensor model number, and the inside diameter of the pipe in which the sensor is installed
   - B Other Sensor Brand. The sensor signal frequency per U.S. GPM or the U S GPM per Hz
2. The desired flow rate measuring range including·
   - A Its full-scale value
   - B Its units of measure (cubic ft /minute, liters/hour, etc.)
   - C Its display resolution (whole units, tenths, hundredths, etc)

Accessories (ordered separately):

- **Panel Cutout Gasket Kit 1000G1110**

  For use when panel mounting Model 675F to provide NEMA 4 integrity behind the panel. Kit includes neoprene gasket and aluminum stiffener plate.

- **Vertical Pipe-Mount Kit 1000A1077**

  For use when mounting Model 675F to a vertical pipe Kit includes vertical pipe mounting bracket and associated hardware.

- **Impeller Flow Sensors**

  For GLI tee-mount flow sensors (for 1/2 to 4 inch pipe sizes), refer to data sheet F1A11.

  For GLI "hot tap" and pipe thread flow sensors (for 3 to 100 inch pipe sizes), refer to data sheet F1A13.

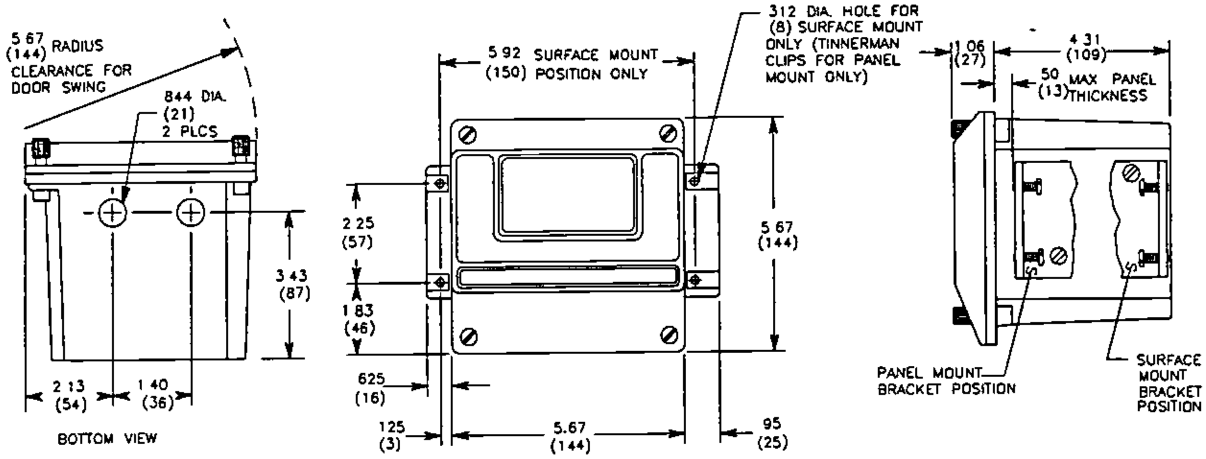
Engineering Specification

1. The flow rate monitor/totalizer shall have a two-line LCD display with seven 3/8 inch (9 5 mm) high digits per line The upper line shall display flow rate in GPM, LPM or other measurement units The lower line shall display total accumulated flow in U S gallons, liters or other measurement units
2. The flow rate monitor/totalizer shall simultaneously display the flow rate and total accumulated flow.
3. The flow rate monitor/totalizer shall have two SPDT relays which can be independently configured to operate in response to increasing or decreasing flow rate Each relay shall have setpoint and deadband adjustments.
4. The flow rate monitor/totalizer shall have three analog outputs (4-20 mA, 0-100 Hz , and an LSTTL-compatible retransmitted flow input signal), and a 24 VDC scaleable pulse output with adjustable duration (0 1 to 2 5 seconds).
5. The flow rate monitor/totalizer shall operate on
   a) 115 volts, 50/60 Hz
   b) 230 volts, 50/60 Hz
   c) 24 VDC
6. The flow rate monitor/totalizer enclosure shall be NEMA 4X, 1/2 DIN size and include hardware for panel, surface or pipe mounting
7. The flow rate monitor/totalizer shall be GLI International, Inc Model 675F.

685 71

Dimensions

Inches (mm)



Panel Cutout 5 43 in (138 mm) square

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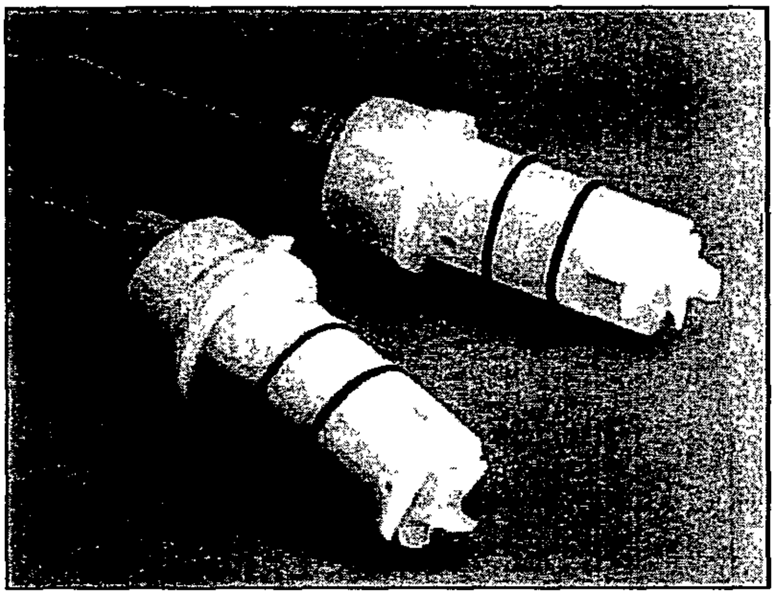
GLI International

Technology For Solutions

Data Sheet F1A11/199
Supersedes F1A11/298

Tee-Mount Flow Sensors

(For Pipe Sizes From 1/2 to 4 Inches)



Model F1A11A1T (polypropylene) and F1A11B2T (PVDF) Sensors

- Flow Sensor Wetted Materials -

	F1A11A1T	F1A11B2T
Body	Polypropylene	PVDF
Impeller	Polypropylene	PVDF
Shaft ..	Zirconia ceramic	Zirconia ceramic
O-rings	EPR (ethylene propylene rubber)	Viton

■ **Non-magnetic Sensing Technique.**
These sensors will not attract metal particles which can obstruct the impeller rotation of conventional magnetic paddlewheel sensors.

■ **Pulsed Output.**
The pulsed output of these sensors has high noise immunity, enabling signal transmission of up to 2000 ft. (610 m) without amplification.

■ **Wide Rangeability.**
GLI impeller flow sensors provide a rangeability of 30 to 1, and can measure most low viscosity liquids.

■ **Superior Low-Velocity Performance.**
The impeller of a GLI flow sensor is not impeded by magnetic drag, ensuring accuracy within ±1% for velocities down to 1 ft./sec. (0.3 m/sec).

■ **FDA-approved Wetted Materials.**
The FDA-approved wetted sensor materials (see above) are chemically compatible with most processes.

■ **Six-Bladed Impeller Design.**
The forward-swept, six-bladed impeller has significantly better low-flow, low-velocity characteristics than conventional four-bladed impellers, providing higher measurement accuracy.

685 73

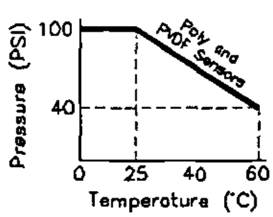
Specifications

	Model F1A11A1T Polypropylene Sensor	Model F1A11B2T PVDF Sensor
Maximum Temperature·		
In PVC Tee	140°F at 40 psi (60°C at 2 75 bar)	140°F at 40 psi (60°C at 2 75 bar)
In Cast Bronze Tee	176°F at 400 psi (80°C at 27 5 bar)	221°F at 400 psi (105°C at 27 5 bar)
In PVDF Tee	140°F at 40 psi (60°C at 2 75 bar)	176°F at 100 psi (80°C at 6 9 bar)
Maximum Pressure		
In PVC Tee	100 psi at 77°F (6.9 bar at 25°C)	100 psi at 77°F (6 9 bar at 25°C)
In Cast Bronze Tee	400 psi at 176°F (27 5 bar at 80°C)	400 psi at 221°F (27 5 bar at 105°C)
In PVDF Tee	100 psi at 77°F (6 9 bar at 25°C)	230 psi at 68°F (15 8 bar at 20°C)
Measuring Range	See mounting tee tables on next page	See mounting tee tables on next page
Repeatability (in any tee)	±0.5% of full scale	±0.5% of full scale
Linearity (in any tee)	±1% of full scale	±1% of full scale
Accuracy▲		
In PVC Tee	±1% of full scale from 1-30 ft /sec (0 3-9 0 m/sec)	±1% of full scale from 1-30 ft /sec. (0 3-9 0 m/sec)
In Cast Bronze Tee	±1% of full scale from 1-20 ft./sec (0 3-6 0 m/sec.)	±1% of full scale from 1-20 ft./sec (0.3-6 0 m/sec)
In PVDF Tee	±1% of full scale from 1-30 ft /sec (0 3-9 0 m/sec)	±1% of full scale from 1-30 ft /sec (0 3-9 0 m/sec)
Sensor Cable	2 conductor (plus shield), 20 ft (6 m)	2 conductor (plus shield), 20 ft (6 m)

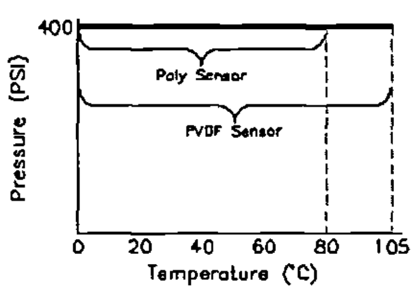
▲Accuracy is attained with at least 10 diameters of straight pipe upstream of sensor and at least 5 diameters of straight pipe downstream from sensor, **and with full pipe flow.**

Sensor Pressure/Temperature Ratings

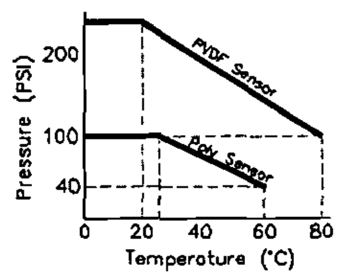
- In PVC MountingTee -



- In Cast Bronze MountingTee -



- In PVDF MountingTee -



Engineering Specification

1 The sensor shall use a non-magnetic sensing technique.

2 The sensor shall have a six-bladed, forward-swept impeller

3 The sensor impeller shall have an embedded gold-plated chip to generate a pulsed output signal

4 The sensor shall have a zirconia ceramic shaft

5 The sensor shall be installed using a special lock-pin type pipe tee (PVC, cast bronze, or PVDF)

6 *The sensor shall be GLI International, Inc Model* F1A11A1T (polypropylene) or Model F1A11B2T (PVDF)

Ordering Information

MODEL NUMBER
F1A11 Tee-mount style impeller flow sensor

BODY MATERIAL
A1 Polypropylene
B2 PVDF

RESERVED CATEGORY

CABLE LENGTH (specify in whole feet)
XX Standard cable length is 20 ft (6 m)

F1A11		T		**Product Number**

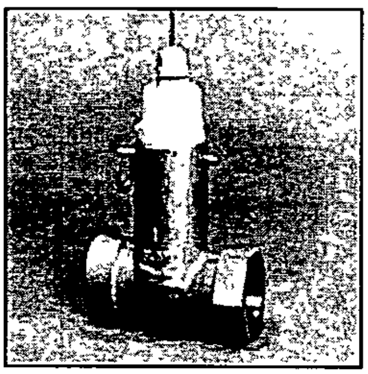
Ordering Information (continued) -- Mounting Hardware

- PVC Tees -

Mounting Hardware Product No	For Pipe Size	Flow Rate		Minimum Instrument Full Scale	Maximum Pressure Drop
		Minimum	Maximum		
MHF15J2	1/2 inch (13 mm)	1 GPM (4 LPM)	35 GPM (133 LPM)	3 GPM (11 LPM)	12 psi (0.8 bar)
MHF15K2	3/4 inch (19 mm)	1 GPM (4 LPM)	35 GPM (133 LPM)	3 GPM (11 LPM)	12 psi (0.8 bar)
MHF15B2	1 inch (25 mm)	1 GPM (4 LPM)	35 GPM (133 LPM)	3 GPM (11 LPM)	12 psi (0.8 bar)
MHF15L2	1 inch (25 mm)	3 GPM (11 LPM)	65 GPM (246 LPM)	7 GPM (26 LPM)	8 psi (0.6 bar)
MHF15D2	1-1/2 inch (38 mm)	6 GPM (23 LPM)	190 GPM (719 LPM)	16 GPM (61 LPM)	4 psi (0.3 bar)
MHF15E2	2 inch (51 mm)	12 GPM (45 LPM)	380 GPM (1439 LPM)	32 GPM (121 LPM)	3 psi (0.2 bar)
MHF15G2	3 inch (76 mm)	25 GPM (95 LPM)	870 GPM (3294 LPM)	70 GPM (265 LPM)	<1 psi (<0.1 bar)
MHF15H2	4 inch (102 mm)	47 GPM (178 LPM)	1635 GPM (6190 LPM)	132 GPM (500 LPM)	<1 psi (<0.1 bar)

All PVC tees listed above have socket-weld process connections

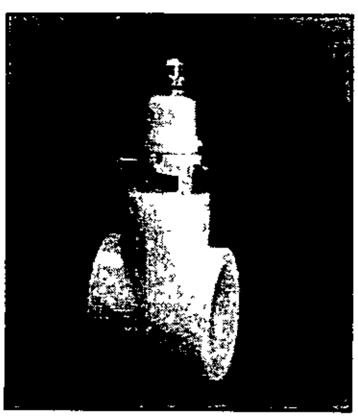
- Cast Bronze Tees -



Mounting Hardware Product No.	For Pipe Size	Flow Rate		Minimum Instrument Full Scale	Maximum Pressure Drop
		Minimum	Maximum		
MHF13B1	1 inch (25 mm)	2 GPM (8 LPM)	65 GPM (246 LPM)	7 GPM (26 LPM)	6 psi (0.4 bar)
MHF13C1	1-1/4 inch (32 mm)	3 GPM (11 LPM)	90 GPM (341 LPM)	8 GPM (30 LPM)	8 psi (0.6 bar)
MHF13D1	1-1/2 inch (38 mm)	4 GPM (15 LPM)	125 GPM (473 LPM)	10 GPM (38 LPM)	8 psi (0.6 bar)

All cast bronze tees listed above have NPT process connections

- PVDF Tees -



Mounting Hardware Product No.	For Pipe Size	Flow Rate		Minimum Instrument Full Scale	Maximum Pressure Drop
		Minimum	Maximum		
MHF16D2	1-1/2 inch (50 mm)	11 GPM (42 LPM)	380 GPM (1439 LPM)	30 GPM (114 LPM)	3 psi (0.2 bar)
MHF16E2	2 inch (63 mm)	13 GPM (49 LPM)	410 GPM (1552 LPM)	34 GPM (129 LPM)	3 psi (0.2 bar)
MHF16G2	3 inch (90 mm)	29 GPM (110 LPM)	950 GPM (3597 LPM)	78 GPM (295 LPM)	<1 psi (<0.1 bar)
MHF16H2	4 inch (110 mm)	51 GPM (193 LPM)	1585 GPM (6001 LPM)	133 GPM (503 LPM)	<1 psi (<0.1 bar)

All PVDF tees listed above have socket-weld process connections and are directly compatible with metric-sized PVDF piping systems such as SYGEF®

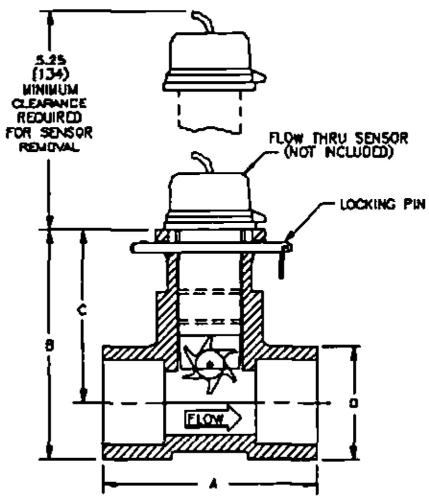
685 75

Ordering Information (continued) -- Sensor Repair Kits

- **Polypropylene Flow Sensor Repair Kit F1-1001-101**
  For Model F1A11A1T flow sensor. Kit includes new impeller, shaft, and O-rings.

- **PVDF Flow Sensor Repair Kit F1-1001-102**
  For Model F1A11B2T flow sensor. Kit includes new impeller, shaft, and O-rings.

Dimensions



Model F1A11A1T (Polypropylene) and Model F1A11B2T (PVDF) Sensors

Mounting Tee			Dimensions in inches (mm)			
Material	**Pipe Size**	**For Pipe With:**	**A**	**B**	**C**	**D**
PVC	1/2 inch	0 84 in (21.34 mm) outside diameter	5.3 (135)	4 84 (123)	3.59 (91)	2 5 (64)
	3/4 inch	1 05 in (26 67 mm) outside diameter	5 3 (135)	4 84 (123)	3 59 (91)	2 5 (64)
	1 inch	1 315 in (33 4 mm) outside diameter	5 3 (135)	4 84 (123)	3 59 (91)	2 5 (64)
	1-1/2 in	1 9 in (48 26 mm) outside diameter	4 94 (125)	5 11 (130)	3 86 (98)	2 5 (64)
	2 inch	2 375 in (60 32 mm) outside diameter	5 5 (140)	5 58 (142)	4 05 (103)	3 06 (78)
	3 inch	3 5 in (88 9 mm) outside diameter	6 5 (165)	6 78 (172)	4 65 (118)	4 25 (108)
	4 inch	4 5 in (114 3 mm) outside diameter	7 38 (187)	7 9 (201)	5.15 (191)	5 5 (140)
Cast Bronze	1 inch	1 inch NPT threads	5 5 (140)	4 5 (114)	3 5 (89)	2 25 (57)
	1-1/4 in	1-1/4 inch NPT threads	6 25 (159)	4 75 (121)	3 63 (92)	2 25 (57)
	1-1/2 in	1-1/2 inch NPT threads	6 5 (165)	5 0 (127)	3 75 (95)	2 5 (64)
PVDF	1-1/2 in	1 969 in (50 mm) outside diameter	4 0 (102)	5 05 (128)	3.76 (96)	2 59 (66)
	2 inch	2 48 in (63 mm) outside diameter	4 83 (123)	5 38 (137)	3 78 (96)	3.2 (81)
	3 inch	3 543 in (90 mm) outside diameter	6 9 (175)	6 9 (175)	4 68 (119)	4.45 (113)
	4 inch	4 331 in (110 mm) outside diameter	8.3 (211)	7 67 (195)	5 01 (127)	5.32 (135)

This tee has integral reducer bushings for the listed pipe size

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Eastman Way, Hemel Hempstead
Hertfordshire HP2 7HB,
England
phone 01442 229310

685 76

GLI International

OPERATING INSTRUCTION MANUAL

Manual No. 202
Revision 2-494

TEE-MOUNT and PIPE THREAD IMPELLER FLOW SENSORS

GLI International, Inc.
Great Lakes Instruments
9020 West Dean Road
Milwaukee, Wisconsin 53224

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Page(s) 2 & 3

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TABLE OF CONTENTS

685 79

	"Tee-Mount" Sensors (Locking Pin Style)		"Pipe Thread" Sensors (Hex-Mount Style)
	Model F1A11A1(Polypropylene)	**Model F1A11B2 (PVDF)**	**Models F1A12C1 (SS) and F1A12D1 (Brass)**
Maximum Temperature:			
In PVC Tee	60°C (140°F) at 40 psi	60°C (140°F) at 40 psi	Not applicable
In Cast Bronze Tee	80°C (176°F) at 400 psi	105°C (221°F) at 400 psi	Not applicable
In PVDF Tee	60°C (140°F) at 40 psi	80°C (176°F) at 100 psi	Not applicable
In Cast Iron Tee	Not applicable	Not applicable	105°C (221°F) at 175 psi
In Brass Tee	Not applicable	Not applicable	105°C (221°F) at 200 psi
In Pipe with weldolet or pipe saddle	Not applicable	Not applicable	105°C (221°F) at 400 psi*
Maximum Pressure:			
In PVC Tee	100 psi at 25°C (77°F)	100 psi at 25°C (77°F)	Not applicable
In Cast Bronze Tee	400 psi at 80°C (176°F)	400 psi at 105°C (221°F)	Not applicable
In PVDF Tee	100 psi at 25°C (77°F)	230 psi at 20°C (68°F)	Not applicable
In Cast Iron Tee	Not applicable	Not applicable	175 psi at 105°C (221°F)
In Brass Tee	Not applicable	Not applicable	200 psi at 105°C (221°F)
In Pipe with weldolet or pipe saddle	Not applicable	Not applicable	400 psi at 105°C(221°F)*
Measuring Range	Up to 30 ft./sec. (limited to 20ft./sec. in cast bronze tee and 20 GPM in 1/2", 3/4" and 1" PVC tees).	Up to 30 ft./sec. (limited to 20 ft./sec. in cast bronze tee and 20 GPM in 1/2", 3/4" and 1" PVC tees).	Up to 30 ft./sec.
Repeatibility:			
In PVC Tee	±0.5% of full scale	±0.5% of full scale	Not applicable
In Cast Bronze Tee	±0.5% of full scale	±0.5% of full scale	Not applicable
In PVDF Tee	±0.5% of full scale	±0.5% of full scale	Not applicable
In Cast Iron Tee	Not applicable	Not applicable	±0.5% of full scale
In Brass Tee	Not applicable	Not applicable	±0.5% of full scale
In Pipe with weldolet or pipe saddle	Not applicable	Not applicable	±0.5% of full scale
Linearity:			
In PVC Tee	±1% of full scale	±1% of full scale	Not applicable
In Cast Bronze Tee	±1% of full scale	±1% of full scale	Not applicable
In PVDF Tee	±1% of full scale	±1% of full scale	Not applicable
In Cast Iron Tee	Not applicable	Not applicable	±1% of full scale
In Brass Tee	Not applicable	Not applicable	±1% of full scale
In Pipe with weldolet or pipe saddle	Not applicable	Not applicable	±1% of full scale
Accuracy▲:			
In PVC Tee	±1% of full scale from 1 to 30 ft./sec.	±1% of full scale from 1 to 30 ft./sec.	Not applicable
In Cast Bronze Tee	±1% of full scale from 1 to 20 ft./sec.	±1% of full scale from 1 to 20 ft./sec.	Not applicable
In PVDF Tee	±1% of full scale from 1 to 30 ft./sec.	±1% of full scale from 1 to 30 ft./sec.	Not applicable
In Cast Iron Tee	Not applicable	Not applicable	±1% of full scale from 1 to 30ft./sec. with GLI supplied tee
In Brass Tee	Not applicable	Not applicable	±1% of full scale from 1 to 30ft./sec. with GLI supplied tee
In Pipe with weldolet or pipe saddle	Not applicable	Not applicable	±1% of full scale from 1 to 30ft./sec. with GLI supplied tee
Sensor Cable	2 conductor (plus shield), 20 ft. (6 m)	2 conductor (plus shield), 20 ft. (6 m)	2 conductor (plus shield), 20 ft. (6m)

*Temperature and pressure may be further limited by ratings of customer supplied weldolet or pipe saddle.
▲*Attained with at least 10 diameters of straight pipe upstream of sensor and 5 diameters of straight pipe downstream from sensor.*

PART TWO - INSTALLATION

SECTION 1 - LOCATION REQUIREMENTS

Flow measurement accuracy is highly dependent on proper location of the sensor in the piping system. A sensor located in a pipe where it can be affected by air bubbles, sediment or floating debris (especially stringy or fibrous material) may not achieve full accuracy and could become damaged. The flow sensor is designed to operate reliably under adverse conditions, but the recommendations contained in this section must be followed to assure full measurement accuracy.

1.1 Along The Pipe

Install the sensor in a straight section of the pipe where there is **at least 10 diameters of pipe length upstream** of the sensor (5 diameters when using a 1", 1-1/4", or 1-1/2" cast bronze tee) and **at least 5 diameters of pipe length downstream** from the sensor (3 diameters when using a 1", 1-1/4" or 1-1/2" cast bronze tee).

NOTE: Pipe bends, valves, other fittings, pipe enlargements and pipe reductions should not be present in this straight length of pipe.

1.2 Radially On The Pipe

For Horizontal Pipe Runs

The preferred sensor location around the circumference of a horizontal pipe is on top. If the sensor must be mounted at an angle, it should be at least 15° above the horizontal plane. Never mount the sensor sideways or below the pipe as sediment (sand, rust, etc.) could collect or excessive wear could occur.

NOTE: Radial sensor locations other than at the top of the pipe can slightly increase impeller friction which may affect sensor performance at flow rates below 1 ft. per second.

For Vertical Pipe Runs

Any sensor location around the circumference of a vertical pipe is acceptable. It is recommended to mount the sensor in a pipe which has an upward flow direction to avoid "spiraling" turbulence. If this is not possible, a straightening vain can be used to eliminate this turbulence effect.

SECTION 2 - MOUNTING

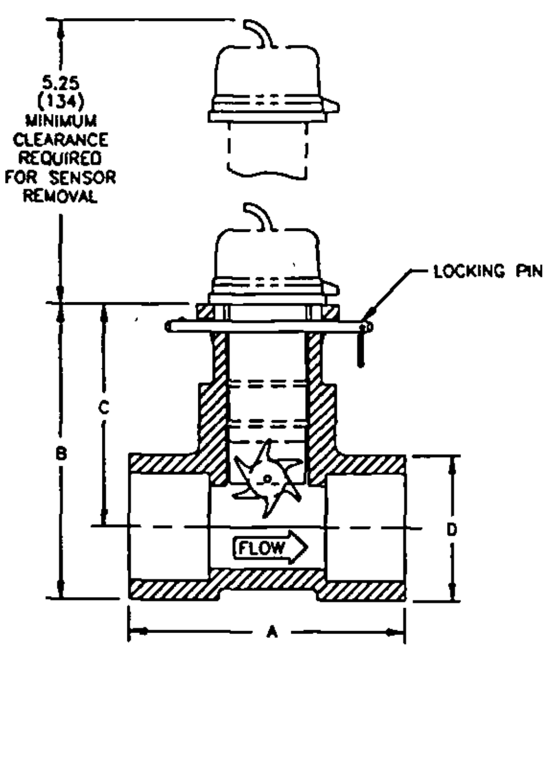
2.1 "Tee-Mount" Locking Pin Style Sensors (Models F1A11A1 and F1A11B2)

This style sensor requires a special mounting tee for installation. The tee may be PVC (for 1/2", 3/4", 1", 1-1/2", 2", 3" or 4" pipe sizes), cast bronze (for 1", 1-1/4" or 1-1/2" pipe sizes) or PVDF (for 1-1/2", 2", 3" or 4" pipe sizes). Refer to Figure 2-1 for mounting details when installing this style sensor.

1. Make sure sensor is removed from tee before installing the tee. Position tee in pipe line so that flow designation on tee corresponds with actual direction of flow in pipe. Solder or weld tee into pipe line.

   NOTE: *If tee is to be installed in copper tubing, it is recommended to install threaded pipe lead-in and exit sections of appropriate length before using copper tubing adapters. This will keep flow disturbances away from the sensor.*

2. Before inserting sensor into tee, apply a small amount of silicone grease from the provided packet onto sensor O-rings and the chamfer on inside lip of tee. Clean off any



Mounting Tee Material	Pipe Size	For Pipe With	Dimensions* A	B	C	D
PVC	1/2 in◊	0.840 O.D. (21.34) O.D.	5.30 (135)	5.10 (130)	3.86 (98)	2.50 (64)
	3/4 in◊	1.050 O.D. (26.67) O.D.	5.30 (135)	5.10 (130)	3.86 (98)	2.50 (64)
	1 in◊	1.315 O.D. (33.40) O.D.	5.30 (135)	5.10 (130)	3.86 (98)	2.50 (64)
	1-1/2 in	1.900 O.D. (48.26) O.D.	4.94 (125)	5.10 (130)	3.86 (98)	2.50 (64)
	2 in	2.375 O.D. (60.32) O.D.	5.50 (140)	5.60 (142)	4.07 (103)	3.06 (78)
	3 in	3.500 O.D. (88.90) O.D.	6.50 (165)	6.82 (173)	4.69 (119)	4.25 (108)
	4 in	4.500 O.D. (114.30) O.D.	7.35 (187)	7.93 (201)	5.18 (132)	5.50 (140)
Cast Bronze	1 in	1" NPT	5.50 (140)	4.50 (114)	3.50 (89)	2.00 (51)
	1-1/4 in	1-1/4" NPT	6.25 (159)	4.75 (121)	3.63 (92)	2.25 (57)
	1-1/2 in	1-1/2 NPT	6.50 (165)	5.00 (127)	3.75 (95)	2.50 (64)
PVDF	1-1/2 in	1.969 O.D. (50) O.D.	4.00 (102)	5.08 (129)	3.79 (96)	2.59 (66)
	2 in	2.480 O.D. (63) O.D.	4.83 (123)	5.65 (144)	4.06 (103)	3.20 (81)
	3 in	3.543 O.D. (90) O.D.	6.90 (175)	5.69 (145)	3.46 (88)	4.45 (113)
	4 in	4.331 O.D. (110) O.D.	8.30 (211)	6.90 (175)	4.25 (108)	5.32 (135)

*Dimensions listed in inches and (mm).
◊ This tee has integral reducer bushings for listed pipe size.

FIGURE 2-1 Mounting Details For "Tee-Mount" (Locking Pin Style) Sensors

685 82

excess grease that could get onto impeller or shaft. Align flow arrow on sensor with flow arrow on tee and carefully press sensor straight into tee.

CAUTION: When using a cast bronze tee or a 1/2", 3/4" or 1" PVC tee, the impeller may strike the venturi cavity sides inside the tee if sensor and tee are misaligned. This could damage the sensor impeller or shaft.

3. Insert locking pin through tee and sensor.

2.2 "Pipe Thread" Hex-Mount Style Sensors (Models F1A12C1 and F1A12D1)

This style sensor requires one of the following hardware items for installation:

- 2" or 2-1/2" x 2-1/2" x 2" (cast iron or brass) standard mounting tee
- 2" NPT threaded weldolet
- 2" NPT threaded pipe saddle

Refer to Figures 2-2 through 2-7 for nomenclature and dimensional details when installing this style sensor.

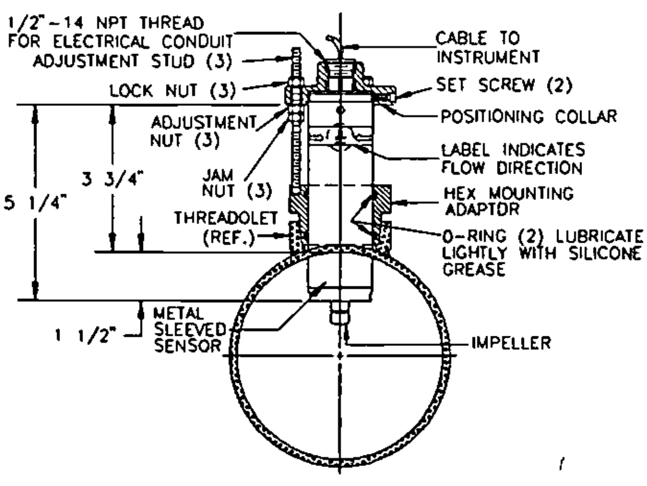


FIGURE 2-2
Installing "Pipe Thread" (Hex-Mount Style) Sensor Into Weldolet

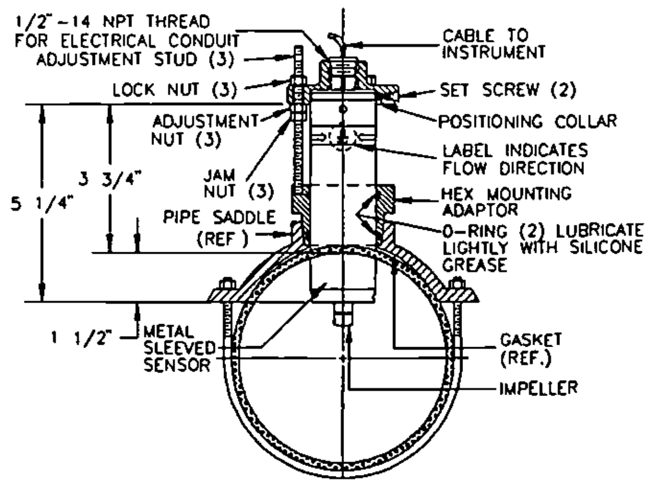


FIGURE 2-3
Installing "Pipe Thread" (Hex-Mount Style) Sensor Into Pipe Saddle

Installing Tee and Hex-Mount Adapter

1. Install mounting tee, weldolet or pipe saddle into the pipe line. Use thread sealant on mounting tee and pipe threads to avoid leaks. Teflon tape or pipe sealant with Teflon (Loctite No. 59231 or equivalent) is recommended. Experience indicates that Teflon tape may not provide an adequate seal, especially at higher solution temperatures.
2. Remove lock nuts from each of the three hex mounting adapter studs. Remove the positioning collar/metal sleeved sensor assembly from hex mounting adapter.
3. Install hex mounting adapter into mounting tee, weldolet or pipe saddle. Use thread sealant as described in step 1.
4. Tighten hex mounting adapter so that <u>no stud</u> is aligned with center of pipe which would later interfere with sensor alignment.

Setting Insertion Depth

1. The **adjustment** nuts on each of the three hex mounting adapter studs must be properly adjusted so that the sensor is mounted at the correct insertion depth.

   A. When Using 2" or 2-1/2" x 2-1/2" x 2" Mounting Tee

   The insertion depth when using a tee is **6.85 inches** as illustrated in Figure 2-4. Turn adjustment nuts to achieve this distance. Secure the jam nuts against the adjustment nuts.

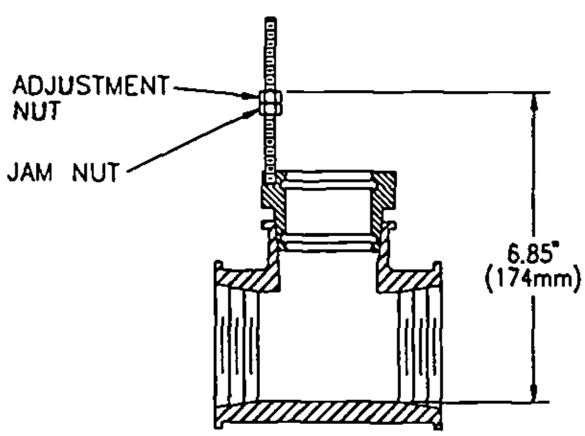


FIGURE 2-4
Insertion Depth When Using Tee

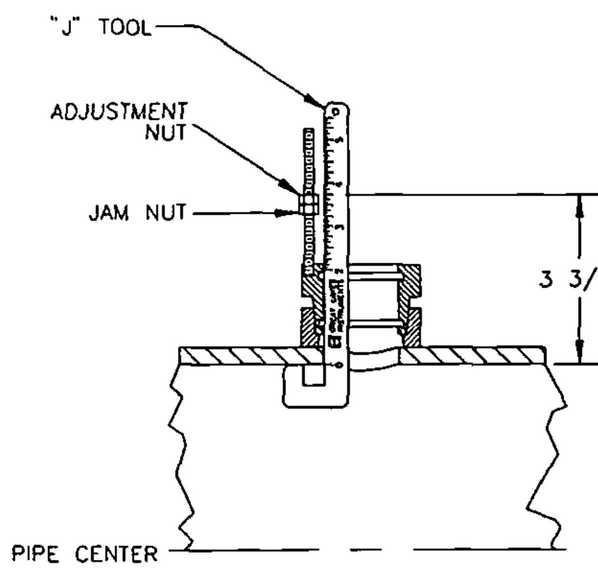


FIGURE 2-5
Insertion Depth When Using Weldolet or Pipe Saddle

685 84

B. When Using 2" Weldolet or Pipe Saddle

Use the insertion depth gauge (provided in sensor accessory kit) to measure the distance from the inside wall of the pipe to the top surface of the adjustment nuts. Tum adjustment nuts so that this distance is 3-3/4" as shown in Figure 2-5. Secure the jam nuts against the adjustment nuts.

2. Before inserting positioning collar/metal sleeved sensor assembly, apply a small amount of silicone grease (provided in sensor accessory kit) onto O-rings in hex mounting adapter. Clean off any excess grease that could get onto impeller or shaft.

3. Make sure sensor sleeve is clean. Insert positioning collar/metal sleeved sensor assembly into hex mounting adapter and align mounting holes in positioning collar with studs on adapter. Lower sensor onto adjustment nuts. Thread lock nuts onto studs and tighten to secure sensor.

Aligning Sensor With Pipe Flow

This procedure aligns the sensor impeller directly into the flow path and assures that the impeller will rotate in the proper direction (Figure 2-6).

1. Loosen two set screws in positioning collar (Figure 2-2 or 2-3) with 3/32" Allen wrench.

2. Refer to Figure 2-7 and place alignment rod (provided in accessory kit) through sight holes in both sides of flow sensor. Turn alignment rod until flow label arrow on sensor is aligned with pipe flow direction (rod should be parallel with pipe).

   NOTE: If flow arrow label is missing, use small hole next to larger sight hole for alignment. Small hole should be on inlet (upstream) side of sensor.

3. Tighten positioning collar set screws with Allen wrench.

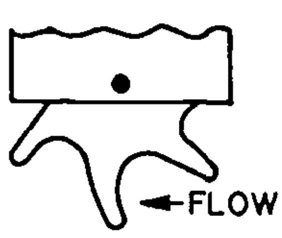


FIGURE 2-6
Impeller Rotation Direction

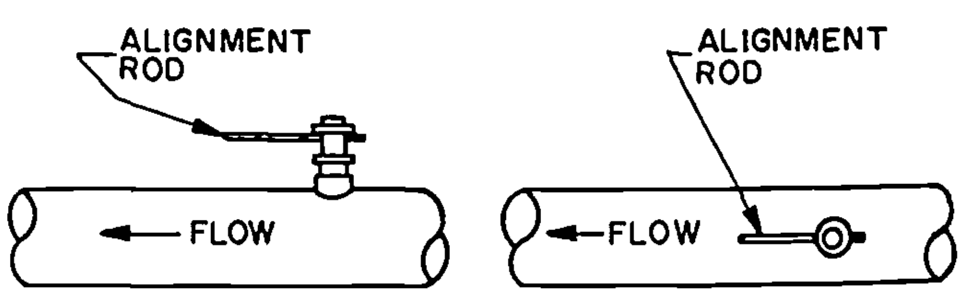


FIGURE 2-7 Flow Alignment Details For "Pipe Thread" (Hex Mount Style) Sensors

SECTION 3 - ELECTRICAL CONNECTIONS

Electrically connect the sensor directly to the instrument or indirectly with a junction box and interconnect cable.

NOTE: *For applications involving a GLI Model 697F and long distances, it is recommended to locate the transmitter within 20 feet of the sensor with the remaining distance being between the transmitter and receiver. This arrangement assures the strongest possible sensor signal by eliminating inductive pick-up which could cause "electrical noise" interference with the signal. However, the sensor may be located up to 2000 feet from the 697F transmitter if necessary.*

3.1 Direct Hook-Up

1. Route sensor cable to instrument. Use a watertight connector, such as a cable feed-thru fitting, in the instrument's cable entry hole.
2. Connect sensor cable wires to instrument in accordance with instrument hook-up instructions.

   NOTE: *The sensor has provisions to allow connection of a standard 1/2" flexible, electrical conduit if desired.*

3.2 Indirect Hook-Up With Junction Box

1. Mount junction box (with terminal strip) on a flat surface such that its cover is removable when installed.
2. Route sensor cable to junction box through a watertight connector such as a cable feed-thru fitting.

   NOTE: *Keep terminal strip dry to prevent problems caused by wet and/or corroded terminals.*

3. Route interconnect cable (GLI p/n 99X1W0980) from junction box to instrument. If cable is too long, cut it to proper length to avoid any interference from inductive pick-up. It is recommended to run this cable in 1/2" or larger metal conduit for protection against moisture and mechanical damage. Use conduit hubs where cable enters the junction box and instrument enclosure.

   NOTE: *Do not run this cable in the same conduit with power or control wiring ("electrical noise" may interfere with sensor signal).*

4. Connect sensor and interconnect cable wires, by matching colors, to junction box terminal strip. Fasten cover onto junction box.
5. Connect interconnect cable wires to instrument in accordance with instrument hook-up instructions.

PART THREE - PRINCIPLE OF OPERATION

These GLI flow sensors feature a six-bladed impeller that turns at a rate proportional to the velocity of the fluid. The sensor's RF (Radio Frequency) circuit detects the rotating conductive element in the impeller and converts the signal to a digital pulse-train proportional to fluid velocity. Knowing the pipe size, the pulses can be converted to flow rate in, for example, gallons per minute.

PART FOUR - SERVICE AND MAINTENANCE

SECTION 1 - RECOMMENDED CLEANING PROCEDURE

The sensor must be kept reasonably clean to maintain measurement accuracy. The time period between cleanings (weeks, months, etc.) is affected by the characteristics of the process solution and can only be determined by operating experience. For example, a sensor operating in waste water that contains stringy or fibrous material may require more frequent cleaning.

1. Rinse the sensor with clean, warm water.
2. Inspect the impeller and shaft. Remove any stringy or fibrous material. Spin the impeller to verify that it turns freely.
3. Check O-rings and replace if necessary. The appropriate repair kit is listed in Part Five.
4. Lightly lubricate O-rings with silicone grease (provided in sensor accessory kit) before reinstalling sensor. Clean off any excess grease that could get onto impeller or shaft.

SECTION 2 - REPLACING THE IMPELLER

The impeller assembly of the flow sensor is designed to be easily removed and replaced for servicing or replacement of worn parts. Refer to Figure 4-1 or 4-2 for replacement details.

1. After removing the sensor from its mounting, note the direction of the impeller blades so that the new impeller will be installed in the same direction of rotation.
2. Hold small diameter metal pin (provided in repair kit)

685 87

against end of old shaft and strike pin lightly with a hammer. When approximately 1 inch of old shaft is extended out, use pliers to carefully pull shaft completely out. Discard old shaft and impeller.

3. Place new impeller in slotted end of sensor with direction of rotation as noted in step 1. Push chamfered end of new shaft into sensor body on the side indicated in Figure 4-1 or 4-2. Lightly strike new shaft until it is flush with sensor body. Be careful not to damage new ceramic shaft.

4. Replace sensor into its mounting hardware:

   A. "Tee-Mount" (Locking Pin Style) Sensor

      a. Before reinstalling sensor, remove the two O-rings on the sensor body and replace with new O-rings from repair kit. Lightly lubricate O-rings with silicone grease (provided in repair kit).

      b. Align flow arrow on sensor with flow arrow on tee and carefully press sensor straight into tee.

      CAUTION: When using a cast bronze tee or 1/2", 3/4" or 1" PVC tee, the impeller may strike the venturi cavity sides inside the tee if sensor and tee are misaligned. This could damage the sensor impeller or shaft.

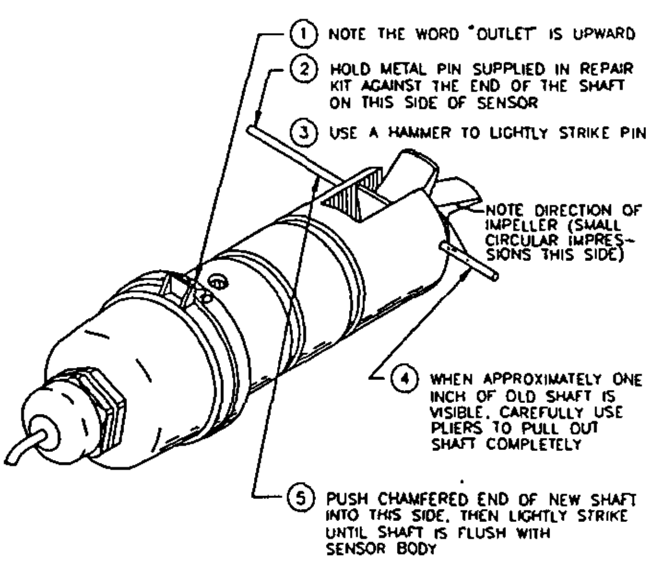


FIGURE 4-1
"Tee-Mount" (Locking Pin Style)
Sensor Impeller Replacement Details

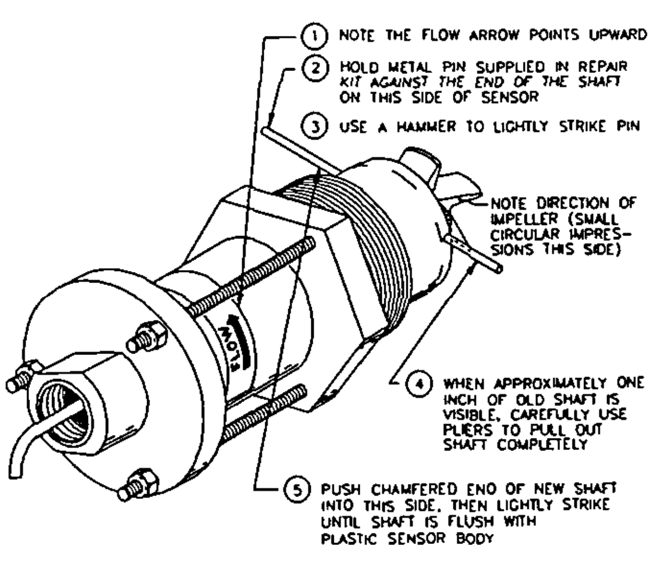


FIGURE 4-2
"Pipe Thread" (Hex-Mount Style)
Sensor Impeller Replacement Details

c. Insert locking pin through tee and sensor.

B. "Pipe Thread" (Hex-Mount Style) Sensor

a. Before reinstalling sensor, remove the two O-rings contained in the hex mounting adapter and replace with new O-rings from repair kit. Lightly lubricate O-rings with silicone grease (provided in repair kit).

b. Clean sensor sleeve and insert sensor into hex mounting adapter. Align flow direction arrows on sensor to correspond with actual direction of flow. Replace lock nuts on each of the three studs and tighten onto positioning collar to secure sensor.

SECTION 3 - TROUBLESHOOTING

3.1 Checking Sensor Operation

A simple check can determine if the sensor is defective when the transmitter and/or indicating instrument are known to be operational:

1. Depressurize and drain process pipe before attempting to remove sensor.

WARNING: FAILURE TO COMPLETELY DEPRESSURIZE THE SYSTEM CAN CAUSE SERIOUS INJURY TO THE SERVICE PERSON.

2. Remove sensor from its mounting hardware:

A. "Tee-Mount" (Locking Pin Style) Sensor

Extract pin from mounting tee. Carefully extract sensor straight out of tee.

B. "Pipe Thread" (Hex-Mount Style) Sensor

Remove **lock** nuts from each of the three hex mounting adapter studs. Remove sensor and its positioning collar from hex mounting adapter.

*NOTE: Do not loosen the two set screws or turn the three **adjustment** nuts. This would disrupt the established alignment position and insertion depth for the sensor when it is reinstalled.*

3. Remove any debris which may be entangled with the sensor impeller and shaft, especially stringy or fibrous material. Inspect impeller blades and shaft for excessive

wear. A repair kit is available from GLI if replacement is necessary. Refer to Part Four, Section 2 for impeller replacement procedure and Part Five for appropriate repair kit part number.

4. Position sensor as shown in Figure 2-6 and spin impeller in the proper direction to simulate flow. The flow indicating instrument should respond with a reading. If not, the electronics in the flow sensor may be defective.

3.2 Customer Assistance

Should service, parts or assistance in troubleshooting or repair be required, please contact your GLI representative or the GLI Customer Service Department:

Great Lakes Instruments, Inc
8855 North 55th Street
Milwaukee, Wisconsin 53223

Telephone: 414/355-3601
Telefax: 414/355-8346

– SERVICE HOURS –

	Eastern Std. Time	Central Std. Time	Mountain Std. Time	Pacific Std. Time
Monday through Thursday	9:00 a.m. to 5:30 p.m.	8:00 a.m. to 4:30 p.m.	7:00 a.m. to 3:30 p.m.	6:00 a.m. to 2:30 p.m.
Friday	9:00 a.m. to 2:00 p.m.	8:00 a.m. to 1:00 p.m.	7:00 a.m. to 12:00 p.m.	6:00 a.m. to 11:00 a.m.

All sensors returned for repair, freight prepaid, should also include the following information:

1. A clearly written description of the malfunction.

2. Name of person to contact and the phone number where they can be reached.

3. Proper return address for shipping sensor(s) back. Include preferred shipping method (UPS, Federal Express, etc.) if applicable.

4. A purchase order if sensor(s) are out of warranty to cover costs of repair.

NOTE: *If the sensor is damaged during return shipment as a result of inadequate packaging, the customer assumes responsibility for repair costs. It is recommended to use the original GLI shipping carton or an equivalent. Also, GLI will not accept sensors returned for repair or replacement unless they are thoroughly cleaned and all process material is removed.*

PART FIVE - SPARE PARTS AND ACCESSORIES

Description	Part Number
Repair Kit* For "Tee-Mount" (Locking Pin Style) Polypropylene Sensor (Model F1A11A1)	F1-1001-101
Repair Kit* For "Tee-Mount" (Locking Pin Style) PVDF Sensor (Model F1A11B2)	F1-1001-102
Repair Kit* For "Pipe Thread" (Hex-Mount Style) Stainless Steel and Brass Sensors (Models F1A12C1 and F1A12D1)	F1-1001-103

*Each repair kit includes impeller, shaft, two O-rings and packet of silicone grease.

Form 167

685 91

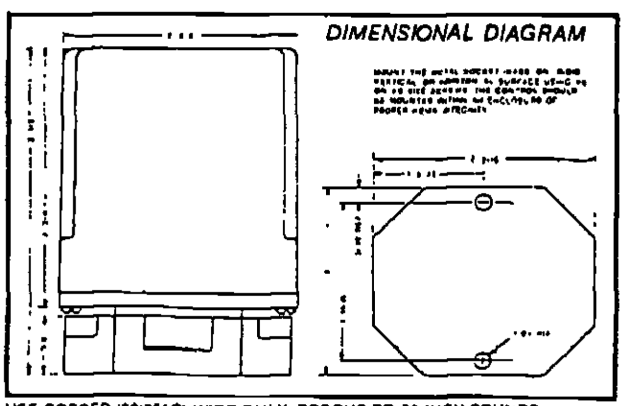
WARRICK CONTROLS

INSTALLATION OF WARRICK SERIES 16M CONTROLS

This bulletin should be used by experienced personnel as a guide to the installation of series 16M controls. Selection or installation of equipment should always be accompanied by competent technical assistance. We encourage you to contact Warrick Controls, Inc. or its representative if further information is required.

SPECIFICATIONS

CONTROL DESIGN: Solid state components enclosed in clear Lexan plug-in style housing. Housing carries no NEMA rating.
CONTACT DESIGN: SPDT (1 form C): one normally open (N.O.) and one normally closed (N.C.), non-powered contacts.
CONTACT RATINGS: 10A @ 120, 240 VAC resistive, 1/3 H.P. @ 120, 240 VAC.
CONTACT LIFE: Mechanical - 5 million operations. Electrical - 100,000 operations minimum at rated load.
SUPPLY VOLTAGE: 24, 120 or 240 VAC models, plus 10%, minus 15%, 50/60 Hz.
SUPPLY CURRENT: 120, 240, 24 VAC, Relay energized 4.4 VA.
SECONDARY CIRCUIT: 12 VAC RMS voltage on probes, 1.5 milli-amp current.
SENSITIVITY: Models operate from 0-1,000,000 OHM maximum specific resistance.
TEMPERATURE: -40 to 150 degrees F. ambient.
TERMINALS: All connections #6-32 screw type terminals with pressure clamps.
TIME DELAYS: Standard, .5 seconds on rising level.
LISTING: U.L. listed, Industrial Motor Control (508).



USE COPPER (60/75°C) WIRE ONLY TORQUE TO 20 INCH-POUNDS.

INSTALLATION

1) Install octal socket in appropriate enclosure using two (2) #6 or #8 metal screws.
1A) Install rail mount socket on appropriate rail (DIN mount) in appropriate enclosure.
2) Wire control per wiring diagram, following N.E.C. and local codes.
3) Install control module in socket.

SENSITIVITIES VS MAXIMUM PROBE WIRE DISTANCE*

SENSITIVITY CHAR.	SENSITIVITY (KOHMS)	DISTANCE (FT)
A or K	4.7	10,000
B or L	10	5,700
C or M	26	2,200
D or N	50	1,075
E or P	100	570
F or R	470	270
G or S	1,000	38

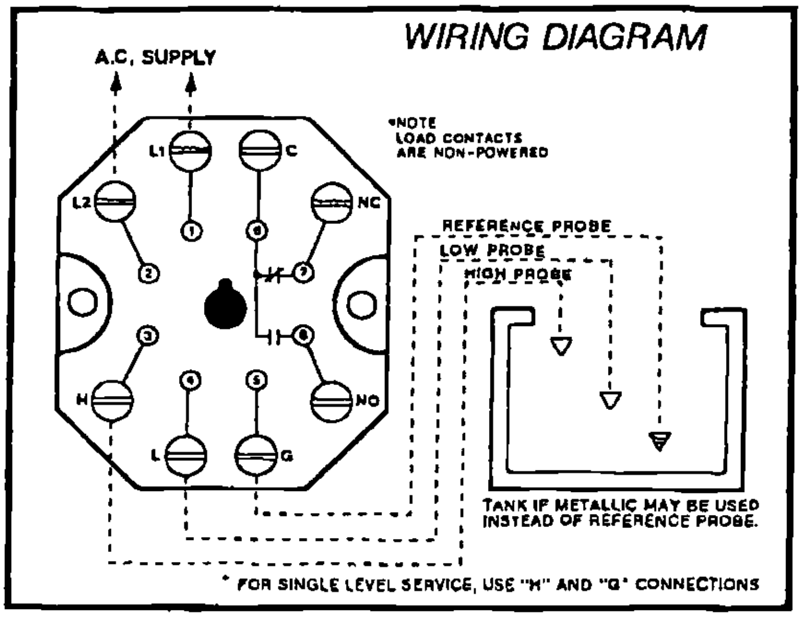
**Based on type MTW or THHN wire, #14 or #16 Awg.*

MODEL NUMBER DESIGNATION

16MXXXX-X-XX-XX

- Time Delay: (decreasing level) 1-20 sec.
- Time Delay (increasing level) 1-20 sec.
- Optional Character:
- Enclosure: 0-none, 1-NEMA 1, 4-NEMA 4, 7-NEMA 7, 12-NEMA 12.
- Socket Style: A-8-PIN octal, B-8-PIN DIN mount, M-none, module only.
- Supply Voltage: 1-120VAC, 2-240VAC, 3-24VAC.
- Mode/Sensitivity: Direct A-4.7K, B-10K, C-26K, D-50K, E-100K, F-470K, G-1M, Inverse K-4.7K, L-10K, M-26K, N-50K, P-100K, R-470K, S-1M
- SERIES 16M CONTROL/module design

OPERATION OF WARRICK SERIES 16M CONTROLS



OPERATION

Direct Mode; Single Level Service: When the liquid rises to the electrode on terminal 3, the control energizes, changing state of the load contacts. (LED will be lit). The control remains energized until the liquid level recedes below electrode on terminal 3. The control then de-energizes, (LED will not be lit) returning load contacts to original state.

Inverse Mode, Single Level Service: Control energizes with power, changing the state of the load contacts. (LED will be lit). When the liquid rises to the electrode on terminal 3, the control de-energizes, returning load contacts to shelf state. (LED will not be lit). The control remains de-energized until the liquid level recedes below electrode on terminal 3, the control then energizes.

Direct Mode, Differential Service: When the liquid rises to the electrode on terminal 3, the control energizes, changing the state of the load contacts. (LED will be lit). The control remains energized until the liquid level recedes below electrode on terminal 4. The control then de-energizes, (LED will not be lit) returning load contacts to original state.

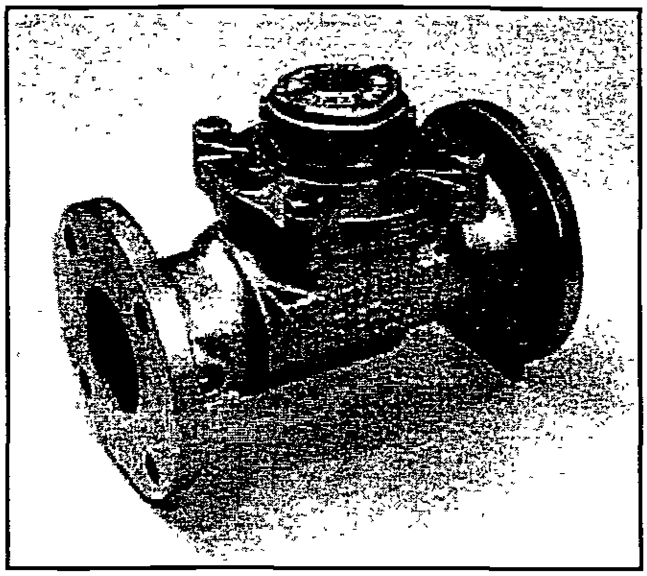
Inverse Mode, Differential Service: Control energizes with power, (LED will be lit) changing the state of the load contacts. When the liquid rises to the electrode on terminal 3, the control de-energizes, returning load contacts to shelf state. (LED will not be lit). The control remains de-energized until the liquid level recedes below electrode on terminal 4. The control then energizes.

OPTIONAL:

Time Delays: With time delay on increasing level, the liquid must be in contact with the short electrode for the full duration of the time delay before control will operate. With delay on decreasing level, the liquid must be below long electrode for the full duration of the time delay before control will operate. In single level service, 3 and 4 terminals must be jumpered together to achieve time delays on both increasing and decreasing levels or just decreasing level.

685 93

Master Meter, Inc.
1 1/2" to 12" MMT Turbine Meters



AWWA Standard
Meets or exceeds all sections of AWWA Standard C-701, Class II Turbines, most recent revision.

Description
Main cases of durable waterworks bronze for 1 1/2" to 8", and cost-effective cast iron for 10" and 12", provide performance, strength and endurance. A nylon inlet flow straightener conditions flows for measurement and screens larger debris. The meters' streamlined flow patterns provide low head loss, reducing the energy required for water delivery. All MMTs incorporate flanged ends.

High strength, precision molded polypropylene rotors insure high accuracy and long service life. MMT Turbines are designed to minimize the net gravitational and buoyant forces on the rotor. The low loads mean high accuracy at lower flows, extended flow ranges to allow meter downsizing without accuracy loss, and lower bearing wear for extended life

Applications
Designed for cold, clean water utility and industrial installations where flow variations are in a 100:1 range.

Register

Options
Standard: meter-mounted register with mechanical odometer.
DIALOG® System: for automatic electronic reading.
Electrical Output: for remote totalization.
Rate of Flow: for remote flow rate data or input to 4-20 mA output unit.

Registration Units
Registration available in U.S. gallons, cubic feet or cubic metres.

Register Sealing
All registers are permanently sealed, with a stainless steel base and wrap-around gasket to prevent intrusion of dirt or moisture. Direct read and DIALOG System registers incorporate a tempered glass lens.

Meter Operating Characteristics & Dimensions

685 94

1 1/2" to 12" MMT Turbine Meters
Meter Operating Characteristics & Dimensions

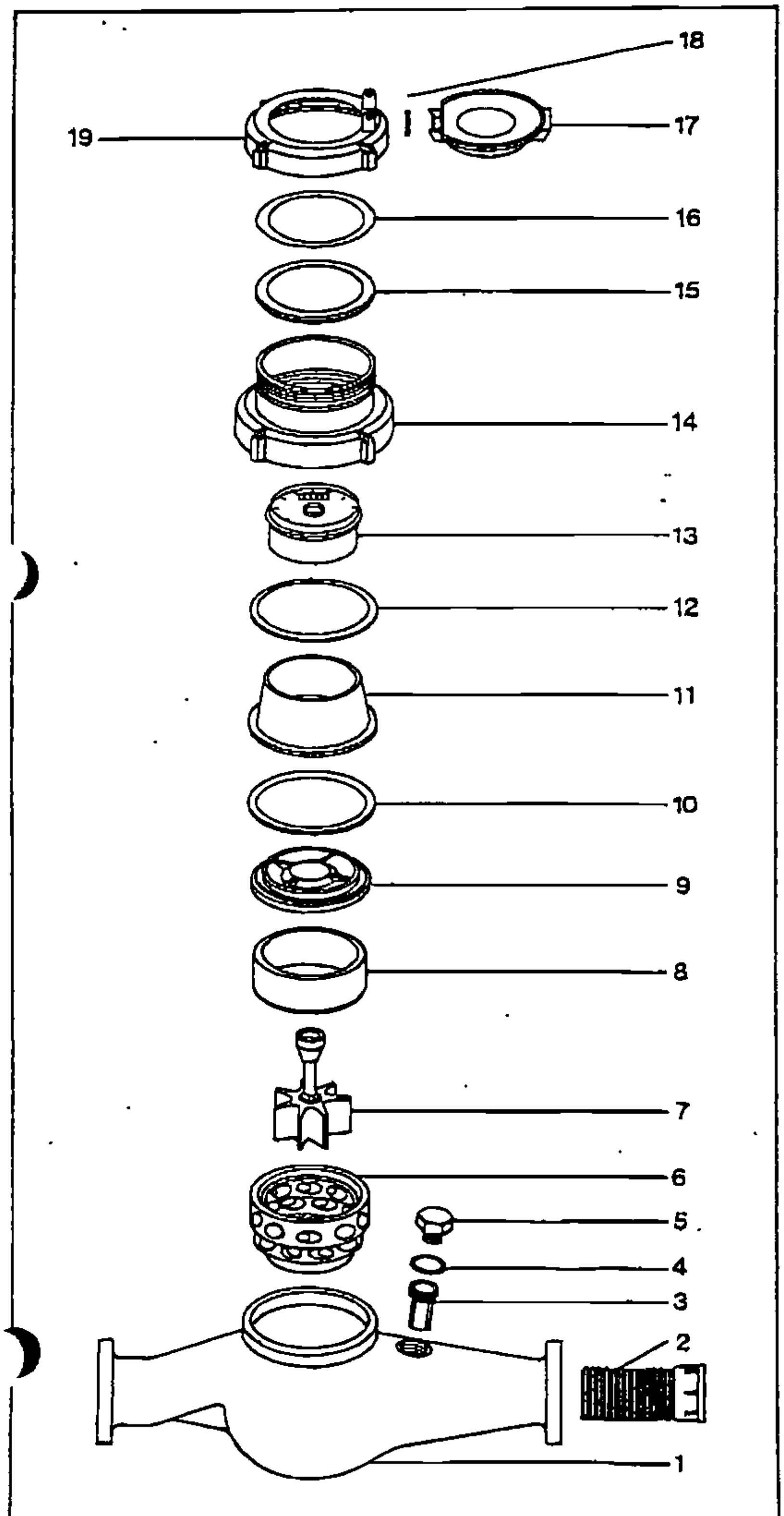
	Meter Size			
Characteristic/Dimension	**1 1/2"**	**2"**	**3"**	**4"**
Operating Range (±1 1/2%) [gpm]	3-160	4 - 350	5 - 530	9 - 1350
Continuous Operating Range [gpm]	3-120	4 - 200	5 - 400	9 - 1000
Low Flow (gpm)	2.5	3	4	8
Maximum Intermittent Flow [gpm]	160	350	530	1350
Maximum Working Pressure (psi)	175	175	175	175
Maximum Working Temperature (°F)	120	120	120	120
Length (inches)	10	10	12.2	14.2
Height (inches)	6.7	8.6	9.6	10.2
Height bottom to center line (inches)	2.2	2.9	3.8	4.4
Width (inches)	5.3	5.9	7.6	9.2
Weight (pounds)	15.6	24	37	42
Register Capacity (millions) - U.S. Gal.	100	100	100	1,000
Register Capacity (millions) - Cu. Ft.	10	10	10	100
Maincase Material	Bronze	Bronze	Bronze	Bronze
Flanges	Elliptical	Elliptical	Round	Round

	Meter Size			
Characteristic/Dimension	**6"**	**8"**	**10"**	**12"**
Operating Range (±1 1/2%) [gpm]	25 - 2700	35 - 3500	60 - 6500	180 - 8800
Continuous Operating Range [gpm]	25 - 2300	35 - 2700	60 - 3300	180 - 4400
Low Flow (gpm)	20	27	44	50
Maximum Intermittent Flow [gpm]	2700	3500	6500	8800
Maximum Working Pressure (psi)	175	175	175	175
Maximum Working Temperature (°F)	120	120	120	120
Length (inches)	18.3	20.3	18.0	20.0
Height (inches)	12.8	13.5	17.5	18.6
Height bottom to center line (inches)	5.6	6.4	8.1	9.2
Width (inches)	11.2	13.7	16.2	18.4
Weight (pounds)	108	140	167	211
Register Capacity (millions) - U.S. Gallons	1,000	10,000	10,000	10,000
Register Capacity (millions) - Cu. Ft.	100	1000	1000	1000

685 95

MASTER METER

Magnetic Multi-Jet Water Meter - 1½"



ILL. NO.	NAME OF PART
1	Main Case-Flanged
1A	Main Case-Threaded
2	End Strainer
3	Regulator Screw
4	Regulator Cap Gasket
5	Regulator Cap
6	Measuring Chamber
7	Rotor with Magnet
8	Spacer
9	Pressure Plate
10	Cover Gasket
11	Pressure Ring
12	Cover Slide Ring
★13	Register
14	Register Box
15	Upper Register Cover Gasket
16	Register Slide Ring
17	Lid-Brass
18	Lid Pin
19	Cover Ring
19A	Cover Ring Assembly (Includes #17, 18, 19)

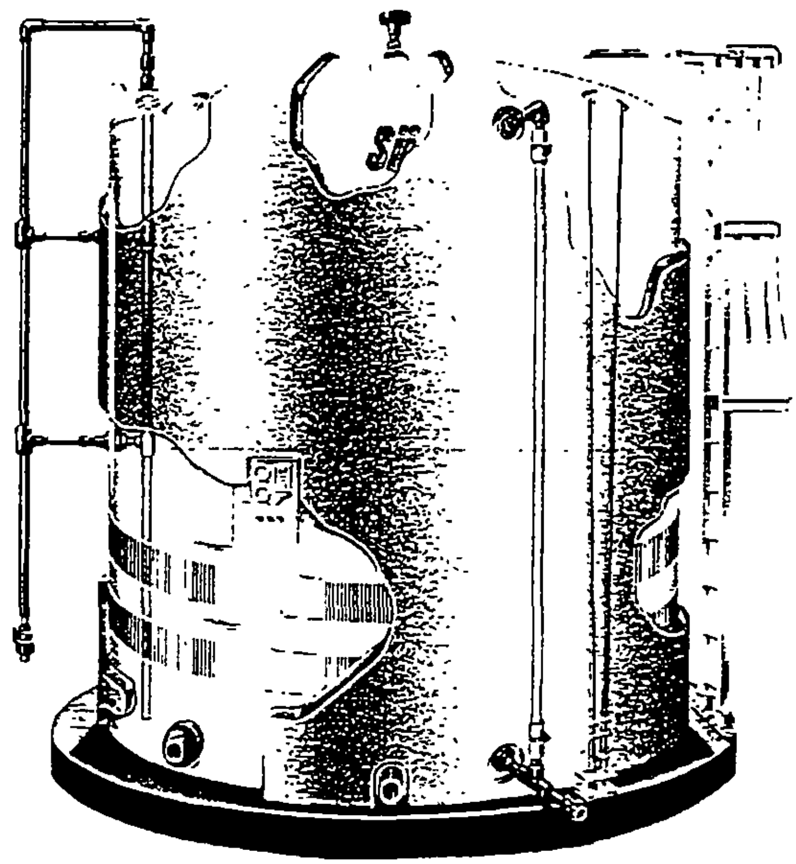
★Specify registration:
U.S. Gallons Cubic Feet Cubic Meters
Part Prices F.O.B. Longview, Texas

FLOW EQUALIZATION SYSTEM

- **Equalization Tank**
- **Equalization Tank Transfer Pump**
- **Level Switch**
- **Overflow Sump Pump**

685 97

GUIDELINES FOR USE AND INSTALLATION



PROVIDING INDUSTRY WITH TANK SOLUTIONS

Sii SNYDER-CROWN
INDUSTRIAL PRODUCTS

4700 FREMONT STREET · P.O. BOX 4583 · LINCOLN, NE 68504-4583

READ THIS MANUAL - WARRANTY INFORMATION INCLUDED

TABLE OF CONTENTS

WARNING: It is the installer's responsibility to follow all appropriate NFPA, OSHA, and governmental safety precautions. The following information has been provided as guidelines for tank use and installation. It does not address safety issues which may be present at specific tank installation sites. Use appropriate safety practices when handling any tank and/or using heavy equipment.

1. TANK LOADING, UNLOADING, AND POSITIONING

1.1 HORIZONTAL TANKS

1.1.1 Tanks shall be wrapped if ordered by the customer.

1.1.2 Tanks should be hand carried, moved with a handling cart, or moved with a forklift with protected or rounded fork extensions (to prevent sharp forks from damaging tanks and to provide adequate support for the tank as it is being moved).

1.1.3 Tanks should be loaded and unloaded from a horizontal position in the truck with a minimal amount of sliding. The tank shall be hand carried, moved with a handling cart, or moved with a forklift with protected or rounded fork extensions to minimize sliding.

1.1.4 Tanks should be loaded or unloaded from a dock of proper height or with a forklift with protected or rounded fork extensions. **NEVER drop a tank off of a truck onto the ground since this may damage the tank and void the warranty.**

1.1.5 <u>Upon arrival at the destination, the purchaser and/or his agent shall be responsible for inspection for damage in transit. If damage has occurred or parts are missing, the purchaser should document this on the bill of lading, file a claim with the carrier, and notify the manufacturer prior to putting the tank into service</u>.

1.2 SMALL VERTICAL TANKS (LESS THAN 2000 GALLON CAPACITY)

1.2.1 Tanks shall be wrapped if ordered by the customer

1.2.2 Tanks should be hand carried, moved with a handling cart, or moved with a forklift with protected or rounded fork extensions (to prevent sharp forks from damaging tanks and to provide adequate support for the tank as it is being moved).

1.2.3 Tanks should be loaded and unloaded from a horizontal or vertical position in the truck with a minimal amount of sliding. The tank shall be hand carried, moved with a handling cart, or moved with a forklift with protected or rounded fork extensions to minimize sliding.

1.2.4 Tanks should be loaded or unloaded from a dock of proper height or with a forklift with protected or rounded fork extensions. **NEVER drop a tank off of a truck onto the ground since this may damage the tank and void the warranty.**

1.2.5 <u>Upon arrival at the destination, the purchaser and/or his agent shall be responsible for inspection for damage in transit. If damage has occurred or parts are missing, the purchaser should document this on the bill of lading, file a claim with the carrier, and notify the manufacturer prior to putting the tank into service.</u>

1.3 LARGE VERTICAL TANKS (GREATER THAN OR EQUAL TO 2000 GALLONS)

1.3.1 Tanks shall be wrapped if ordered by the customer.

1.3.2 Tanks should be moved, loaded, and unloaded in a horizontal position with a forklift with protected or rounded fork extensions, or with a crane with a spreader bar and 2 slings of appropriate size positioned on each tank as shown in Figure 1.1. NEVER drop a tank off of a truck onto the ground since this may damage the tank and void the tank warranty.

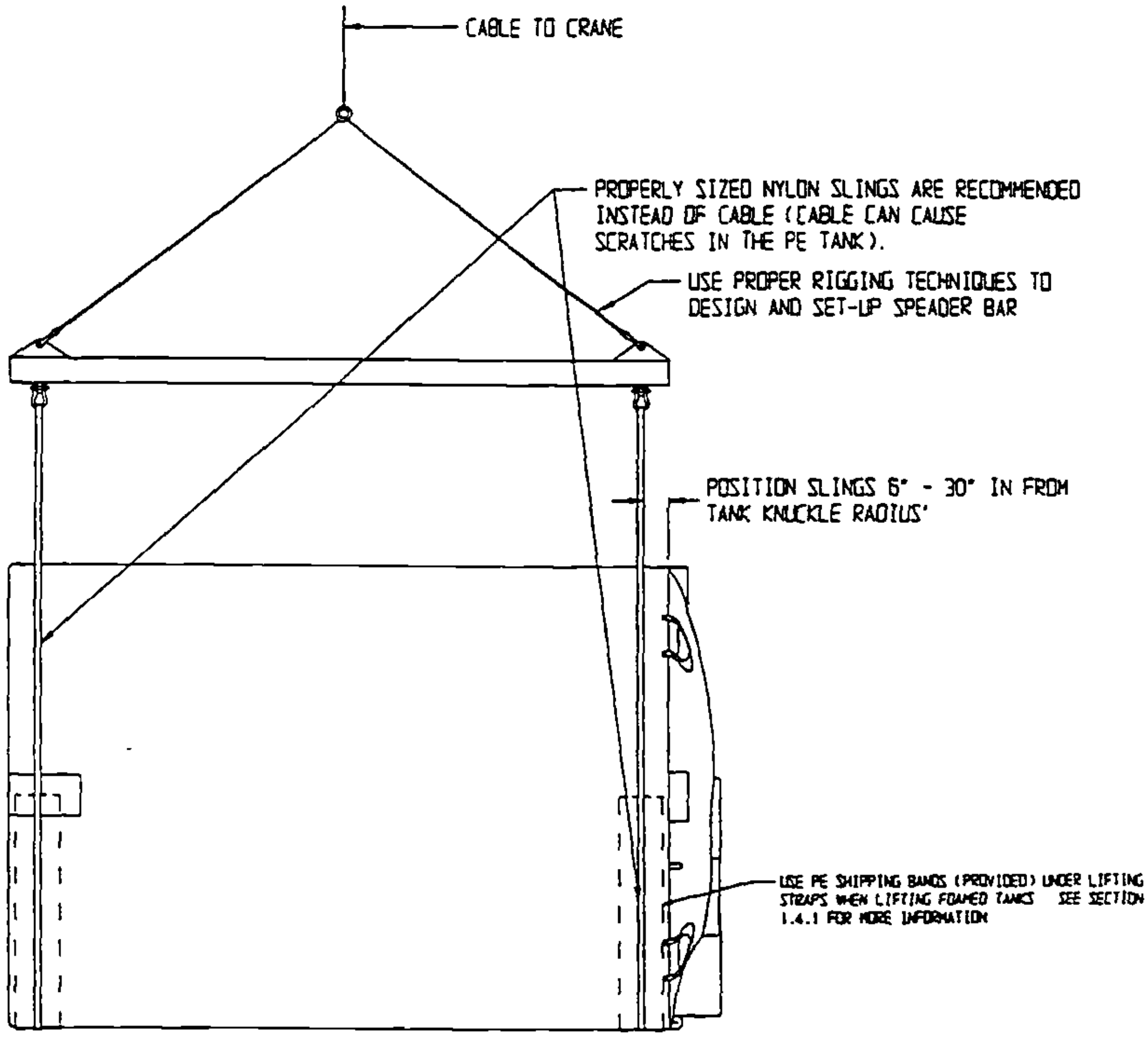
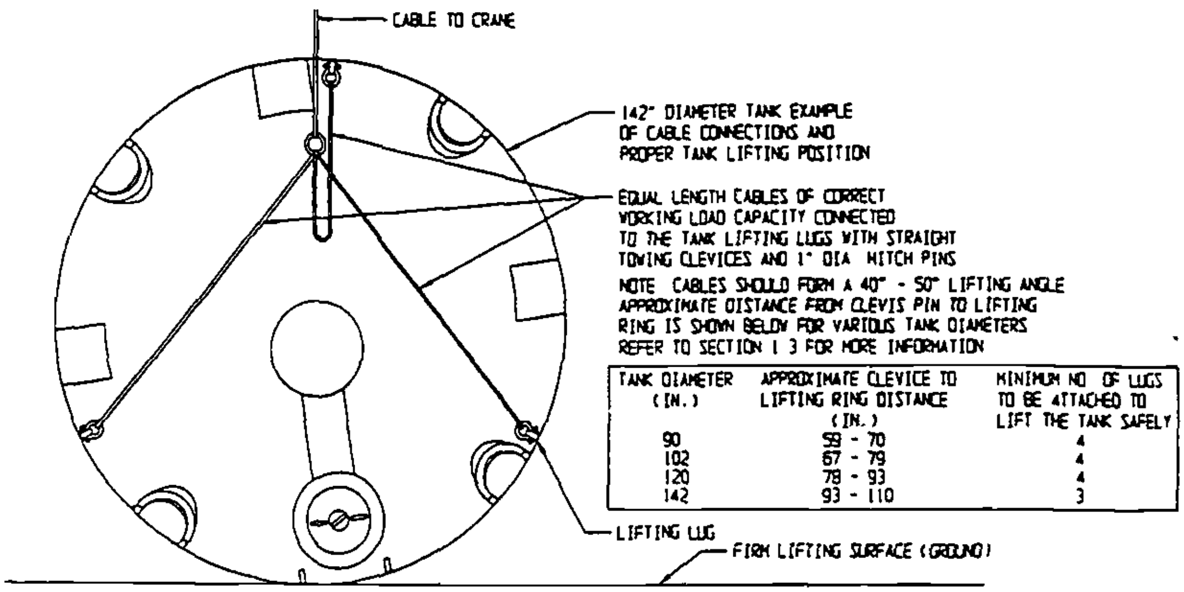


Figure 1.1

1.3.3 Tank lifting lugs are intended for moving the tank from a horizontal position to a vertical position from a firm surface. **Lifting lugs should not be used to load or unload tanks from trailers. This is a dangerous situation since the tank could roll off of the shifting trailer surface as the load is being moved.**

1 3 4 After the tank has been placed on a firm, level surface in a horizontal position, the lifting lugs may be used to erect the tank in a vertical position on an appropriate support pad The tank should be lifted using a symmetrical arrangement of lugs to disperse the load evenly throughout the tank. A minimum of 4 lugs should be attached with equal length cables using straight clevises with 1" diameter pins on all large vertical tank sizes except 142" diameter tanks 142" diameter tanks

require 3 lugs to be attached with equal length cables using straight clevises with 1" diameter pins All tanks should be positioned with 2 lugs closest to the ground prior to lifting the tank to the vertical position. Refer to Figure 1.2 for additional information.



TANK DIAMETER (IN.)	APPROXIMATE CLEVICE TO LIFTING RING DISTANCE (IN.)	MINIMUM NO OF LUGS TO BE ATTACHED TO LIFT THE TANK SAFELY
90	59 - 70	4
102	67 - 79	4
120	78 - 93	4
142	93 - 110	3

Figure 1.2

1.3.5 Upon arrival at the destination, the purchaser and/or his agent shall be responsible for inspection for damage in transit. If damage has occurred or parts are missing, the purchaser should document this on the bill of lading, file a claim with the carrier, and notify the manufacturer prior to putting the tank into service.

1 4 INSULATED TANKS (ADDITIONAL INSTRUCTIONS)

1.4.1 Insulated tanks must be moved with devices that have large padded contact surfaces to prevent damage to the foam insulation. **NEVER allow the tank to drop or roll on rough surfaces as this may damage the foam Insulation.** When transporting foam insulated tanks, use a 30" wide PE sheet 1/4" or more thick conforming to the curvature of the insulated tank as banding supports. This will assist in decreasing the stress on the foam caused by the banding straps.

2. PRE-INSTALLATION NOTES

2.1 TANK OPERATING CRITERIA

2.1.1 TEMPERATURE - All standard SII tanks are designed for a maximum continuous service temperature of 100° F. Service temperatures greater than 100° F reduce the strength of the tank. Applications with temperatures greater than 100° F require greater wall thickness to accommodate this reduction in strength. Please consult factory for applications with service temperatures greater than 100° F.

2.1.2 PRESSURE - All standard SII tanks are designed for use at atmospheric pressure. Pressure or vacuum situations can cause excessive deformation or damage to the tanks. Please consult factory for applications which may develop pressure or vacuum situations.

2.1.3 CHEMICAL COMPATIBILITY - Suitability of the tank assembly (tank, fittings, gaskets, etc.) for storing a particular chemical must be confirmed by chemical data (this should have been done by the tank distributor or the end user prior to placing the tank order). However, changes to the tank (i.e tank accessories, or the service of the tank) can occur. Please consult the factory with any questions.

2.1.4 LOCATION REQUIREMENTS - There may be location requirements which should be considered prior to placing the tank into service. Some items to consider are: secondary containment; locating the tank in a flood plain; locating a tank in an area where seismic or wind forces may be experienced; and heat from surrounding equipment. **It is the responsibility of the end user to ensure that all location requirements have been taken into consideration.** Check for all federal, state, and local regulations that may apply to the tank installation. A thorough evaluation of the proposed tank location prior to tank installation is recommended

2.2 FOUNDATIONS AND SUPPORTS

2.2.1 Vertical flat bottom tanks should be positioned on a concrete pad providing adequate support and a method to attach a tank restraint system. Concrete pad design must be completed by the construction site engineer based on the specific application.

2.2.2 Cone bottom or horizontal tanks require specifically designed support structures. Inadequate or improperly designed support structures may cause premature tank failure. **Therefore, any support structure that is not of SII manufacture must be approved by SII in writing or ALL WARRANTIES WILL BE VOIDED.**

2.3 TANK FITTINGS AND CONNECTIONS

2.3.1 Tank fittings are not typically left installed in the tank since road vibrations, temperature changes, and shipping damage may cause fitting damage and leaks. Customer job site fitting installation insures proper gasket compression and minimizes fitting damage potential. Some distributors sell or install their own tank fittings or accessories. **These fittings or accessories are not warranted by SII.**

2.3.2 All tank connections must have adequate provisions for tank expansion/contraction due to temperature and load changes. These provisions should allow 4% dimensional movement. Rigid piping must not be directly connected to tank outlets. SII strongly recommends using expansion joints for all tank connections. **The use of rigid piping or the failure to provide for the expansion of the tank will void all warranties**.

2.3.3 FITTING INSTALLATION GENERAL GUIDELINES - If fittings are to be customer drilled and installed, there are some general installation guidelines which may be helpful.

2.3.3.1 LOCATION - It is very important that fitting location be carefully considered prior to cutting any holes **SII recommends (fitting size dependent) a 6" minimum centerline height for fittings on tanks less than 3000 gallons with the fitting gasket at least 1-1/2" above or below the end of any tank knuckle radius. SII recommends (fitting size dependent) a 9" minimum centerline height for fittings on tanks 3000 gallons or larger with the fitting gasket at least 3" above or below the end of any tank knuckle radius. SII recommends locating all fittings so gasket seal areas do not go through any tank flange lines or any molded-in tank feature (i.e. gallonage markers, logos, ribs, edges of tank flats, etc.).** Fittings must be located to avoid interference with tie-down devices and to allow for tightening of fittings nut(s) Mark all of the proposed fitting locations with a marker Re-inspect all of the locations prior to cutting any holes

2.3.3.2 TOOLS - It is very important to obtain the correct tools before attempting to install any tank fitting. Tools you will need for installing tank fittings properly include:
*Marker for laying out holes
*Tape measure, straight edge, plum-bob (to align fittings meant to be aligned), etc.
*1/2" drill motor
*Hole saw sized to the O.D. of the fitting body if bulkhead style (see section 3.1, and 3.2).
*Hole saw sized to the I.D. of the fitting flange hole or the same size as the fitting's size if flange style (see section 3.3, and 3.5).
*Drills for any bolt holes (size +1/16" larger than the size of the bolts)
*Deburring tool (a drum sander and 150 - 220 grit sandpaper may also be used)
*Wrenches (adjustable, sockets, strap wrench, etc.)

2.3.3.3 PROCEDURE

1. Disassemble the fitting and use it as a final location check as noted in 2.3.3.1.
2. With the center hole marked, cut the tank hole using the correct size hole saw (see 2.3.3.2).
3. If the fitting is a flange style (see section 3.3 and 3.5) then mark one of the bolt holes using the outer flange. The bolt holes should be oriented so the bolt holes straddle the principal centerline of the tank. With the hole correctly located and marked, drill the bolt hole.
4. Temporarily install one bolt and position the flange over the main fitting hole.
5. Mark the bolt hole opposite the bolt hole already drilled and drill that bolt hole.
6. Temporarily install another bolt and drill the remaining bolt holes using the flange as a guide
7. With all of the fitting's holes drilled, gently deburr the hole(s) with the deburring tool. Do not put any nicks or scratches into the tank. Sand any nicks or scratches out with sandpaper greater than 120 grit.
8. Clean away any debris from the sealing surface of the tank.
9. For tanks greater than 1/2" thick, measure the tank wall thickness. If the wall thickness is not consistent within ± 1/32" around all of the fitting hole(s), some sanding on the inside of the tank wall will be necessary. This must be done carefully and as little as necessary. The purpose of the sanding is to make the wall thickness even, not to create a flat on the tank wall. The final finish sanding should be done with greater than 120 grit sand paper (preferably 220 grit).
10. With all of the fitting's hole(s) prepared, install the fitting using the instructions from the appropriate section (3.1, 3.2, 3.3, or 3.5). The inside tank wall surface must be clean and smooth at time of fitting installation.

2.4 TESTING AND FINAL INSPECTION

2.4.1 After all fittings are installed and all connections to the tank have been made, fill the tank with water and hold for at least 5 hours to identify any leaks. **A record of the water pre-test must be submitted to SII to validate the tank warranty.**

2.5 ACCESSORY PARTS

2.5.1 Various parts must be packaged separately to prevent damage during transportation. These parts are usually bagged or boxed to prevent loss or damage. Some parts may be shipped inside of the tank.

3. FITTINGS

NOTE: The following installation instructions assume the tank has been predrilled and prepared for fitting installation by the factory. See section 2.2 for general tank fitting information if a fitting is to be installed without a factory

685 104

prepared location. Prior to installing fittings, check the sealing surface for debris and/or scratches which could cause leakage.

3.1 THREADED BULKHEAD FITTING

3.1.1 Remove the nut (C) from the fitting body (A) and gasket (B) See Figure 3.1 for part identification.

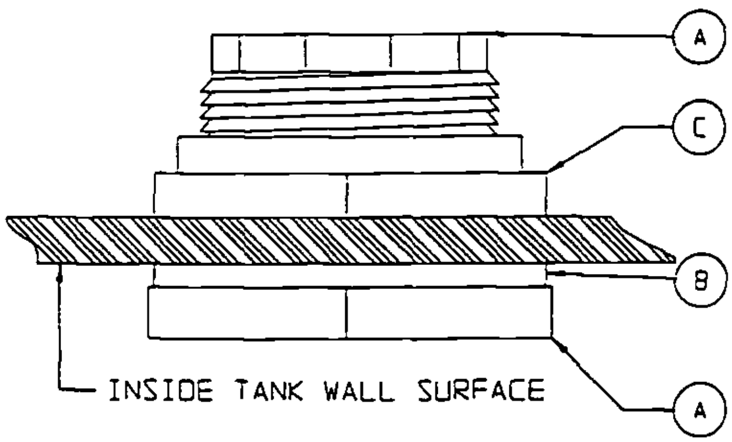


Figure 3.1

3.1.2 Working from inside the tank, slide the fitting body (A) through the hole in the tank. The gasket (B) should be between the fitting body flange and the inside tank wall. Install the nut (C) on the fitting threads protruding on the outside of the tank.

3 1.3 To obtain proper gasket compression for bulkhead fitting installation, tighten the fitting nut hand tight (check to see if it engages the tank wall). *Tighten the nut an additional 3/4 turn* for fittings less than 1 in., or 1/3 turn for fittings 1 in. or larger. A light lubricant, such as PAM cooking spray, is recommended to prevent thread seizing on bulkhead fittings. Inspect the gasket to make sure it is fully contacting the inner surface of the fitting body flange and the inside tank wall. Gasket compression should be between 25 - 50%. **Recheck fitting tightness periodically.**

3.2 SELF-ALIGNING THREADED BULKHEAD FITTING

3.2.1 Follow the same procedures as detailed under threaded bulkhead fitting installation steps 3.1.1 - 3.1.3.

3 2.2 Piping should be installed into the fitting ball with an appropriate thread sealant (i.e. Teflon® pipe sealant). Adjust the piping to the required angle (within the limits of the fitting) When the piping has been located as required, tighten the PVC ball retainer ring located on top of the PVC ball.

3 3 BOLTED FLANGE FITTING

3 3 1 The bolted flange fitting shall be constructed with 2 ea. 150 lb. flanges (C1 and C2), 2 ea 150 lb flange gaskets (D1 and D2) (if used for a tank with less than a 0.75" thick wall at that fitting location), the correct number of full threaded bolts (A), bolt gaskets (B), flat washers (E), lock washers (F), and hex nuts (G) for the flange specified. NOTE: If the tank wall thickness is greater than or equal to 0.75", the inner flange (C1) and the inner flange gasket (D1) will not be provided since they are not necessary for proper fitting function. Refer to Figure 3.2 for part identification

3.3.2 Disassemble the fitting as shipped by removing the bolt's hex nuts, lock washers, flat washers, outer flange, and outer flange gasket Locate the fitting hole on the inside of the tank and insert the bolts (still installed on the inner flange and inner flange gasket if these items are necessary) through the drilled holes in the tank. Place the outer flange gasket over the bolts on the outside surface to the tank. Place the outer flange over the outer gasket and bolts. Install the flat washers, lock washers, and hex nuts on the bolts. Check to make sure the fitting assembly appears as shown in Figure 3.2.

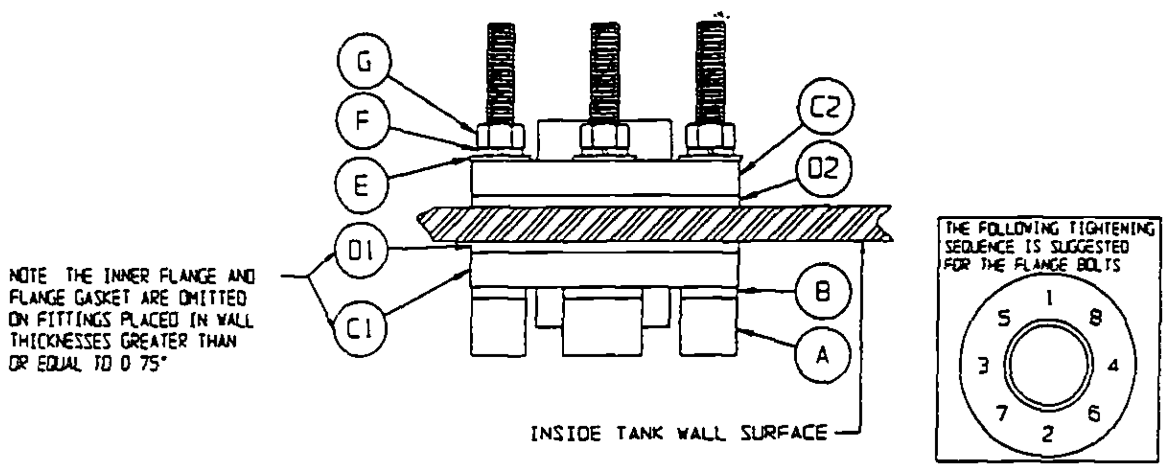


Figure 3.2

3.3 3 To obtain proper gasket compression, tighten all the fitting nuts hand tight with a deep socket using the bolt tightening sequence shown until the gaskets engage the tank wall and the lock washers are compressed. Tighten each nut an additional 3 turns (2 turns if the inner flange and gasket are not utilized) using the same sequence (do not tighten more than 1 turn at a time) A light application of lubricating oil is necessary to prevent thread seizing on S.S bolts. Gasket compression should be between 25 - 50%. **Recheck fitting tightness periodically.**

3 4 BOLTED DOUBLE WALL FLANGED FITTING

3 4.1 The bolted double wall flange fitting shall be constructed with 1 ea. 150 lb. flanged fitting body (C), 1 ea. 150 lb. flange gaskets (D), 1 ea. 150 lb. flange ring (E), the correct number of full threaded bolts (A), bolt gaskets (B), flat washers (F), lock washers (G), and hex nuts (H) for the flange specified. Refer to Figure 3.3 for part identification.

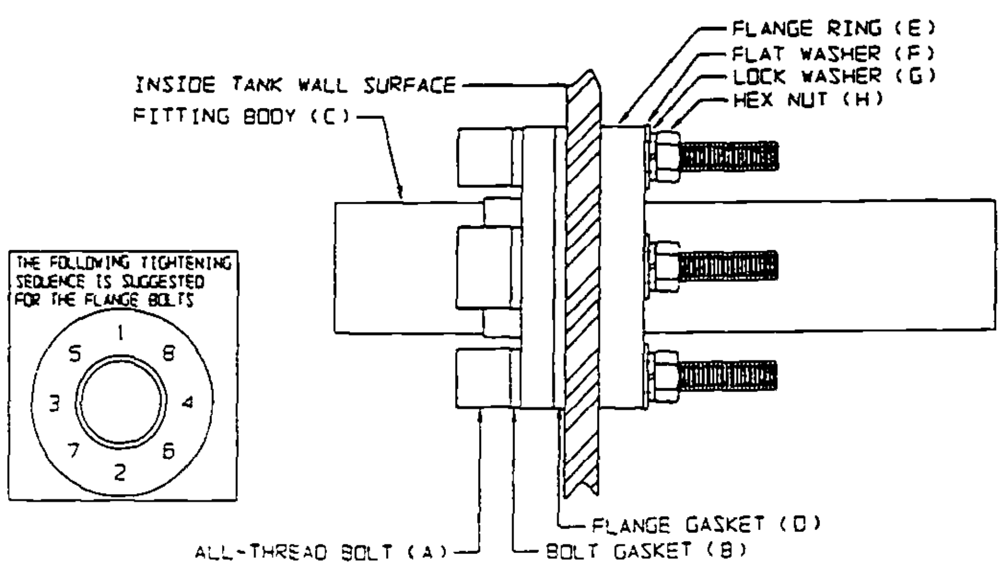


Figure 3 3

685 106

3.4.2 Disassemble the fitting as shipped by removing the bolt's hex nuts, lock washers, flat washers, and flange ring. Locate the fitting hole on the inside of the tank and insert the bolts (still installed on the flanged fitting body and flange gasket) through the drilled holes in the tank. Place the flange ring over the bolts. Install the flat washers, lock washers, and hex nuts on the bolts. Check to make sure the fitting assembly appears as shown in Figure 3.3.

3.4 3 To obtain proper gasket compression, tighten all the fitting nuts hand tight with a deep socket using the bolt tightening sequence shown until the gasket engages the tank wall and the lock washers are compressed. Tighten each nut an additional 2 turns using the same tightening sequence (do not tighten more than 1 turn at a time). A light application of lubricating oil is necessary to prevent thread seizing on S.S. bolts. Gasket compression should be between 25 - 50%. **Recheck fitting tightness periodically.**

3.5 BOLTED STAINLESS STEEL FITTING

3.5.1 The bolted stainless steel fitting shall be constructed with 1 ea. inside flange with studs (A), 2 ea. fitting gaskets (B), 1 ea. outside flange (C), and the correct number of lock washers (D), and hex nuts (E) for the fitting specified. Refer to Figure 3 4 for part identification.

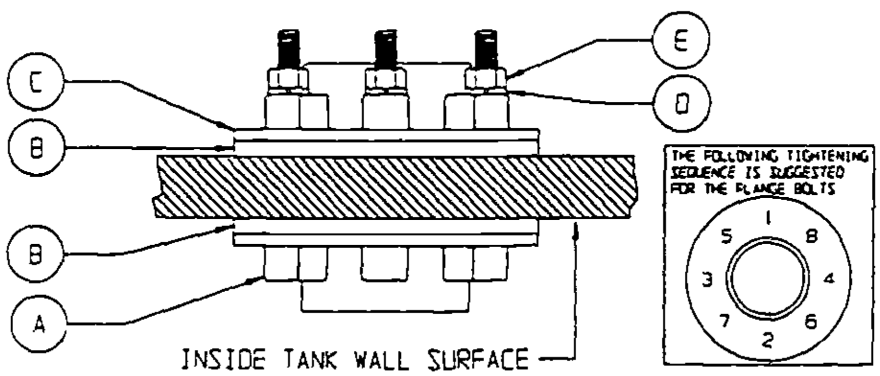


Figure 3.4

3.5 2 Disassemble the fitting as shipped by removing the hex nuts, lock washers, outside flange and outside flange gasket. Locate the fitting hole on the inside of the tank and insert the fitting's studs through the drilled holes in the tank. A gasket (B) should be between the inside fitting flange and the inside tank wall. Place the outside flange gasket and outside flange over the studs on the outside surface of the tank. Install the lock washers and hex nuts on the studs. Check to make sure the fitting assembly appears as shown in Figure 3.4.

3.5.3 To obtain proper gasket compression, tighten all the fitting nuts hand tight with a deep socket using the bolt tightening sequence shown until the gasket engages the tank wall and the lock washers are compressed. Tighten each nut an additional 1-1/4 - 2 turns using the same sequence (do not tighten more than 1 turn at a time). Do not apply more than 15 ft. - lbs of torque. A light application of lubricating oil is necessary to prevent thread seizing on S.S bolts Gasket compression should be between 25 - 50%. **Recheck gasket tightness periodically.**

3 6 SNYDER UNITIZED MOLDED OUTLET - (SUMO™) (PATENT NO. 5,374,026)

3.6 1 The SUMO fitting shall be constructed with 1 ea. smaller o-ring (A), 1 ea. larger o-ring (B), and 1 ea. SUMO adapter (C). Refer to Figure 3 5 for part identification NOTE - The tank is shipped with a shipping stabilizer installed in the SUMO outlet. NEVER move the container without the shipping stabilizer installed.

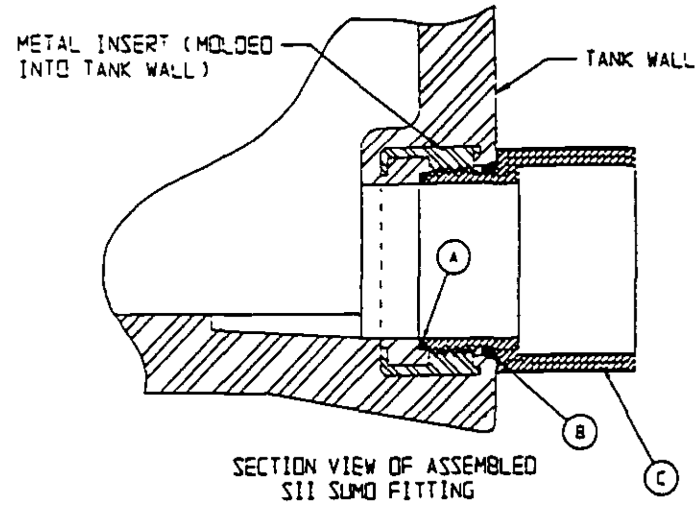


Figure 3.5

3.6.2 Once the tank has been properly placed on its foundation, remove the shipping stabilizer and clean away any dirt or debris from the SUMO outlet threads and o-ring seats. Use only a soft moist cloth. NEVER USE A TOOL THAT COULD SCRATCH THE O-RING SEATS.

3 6.3 Install the smaller o-ring inside the SUMO molded-in fitting. Make sure it is placed in the o-nng seat area evenly. Carefully stretch the larger o-ring enough to install it on the SUMO adapter. The o-nng may be lubricated with a suitable lubricant such as water. Screw the adapter in until the step on the adapter is flush with the tank wall. Do not over-torque the adapter (25 ft. - lbs. of torque maximum). Figure 3.5 shows a sectional view of an assembled SUMO fitting

3.6.4 Once the SUMO adapter is installed, other components may be attached to the adapter. A union or flange adapter with a flexible expansion joint should be installed as close to the tank as possible to allow for future disassembly

3 7 SIPHON TUBE FITTINGS

3.7.1 Siphon tubes may be added to the fittings specified in sections 3.1, 3.3, 3.4, and 3.5. Siphon tubes shall be customer installed with the tank in a vertical position after fitting installation.

3.7.2 PVC and CPVC siphon tubes need to be solvent welded with the proper solvent cement into the socket of a previously installed fitting. Threaded siphon tubes need to be threaded in place with Teflon® pipe sealant applied to the threads pnor to the fitting being installed.

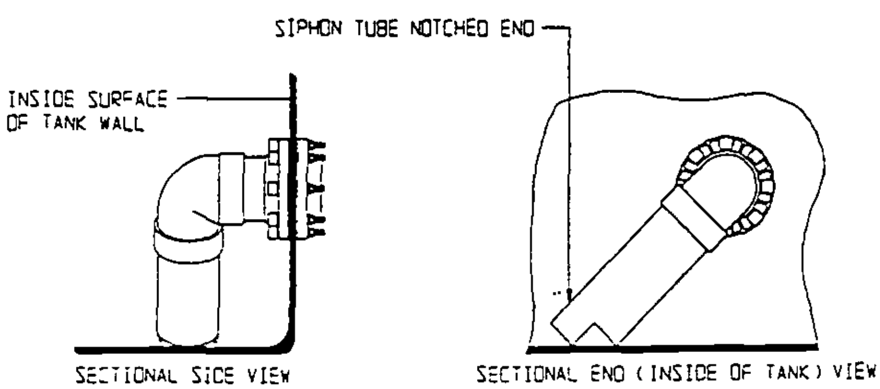


Figure 3 6

3.7.3 Siphon tubes should be located with the cut notch corner in close proximity of the floor of the tank for maximum drainage, and the siphon tube tilted to the side of the fitting. Refer to Figure 3.6 for proper placement of the siphon tube in the tank.

4. TANK ATTACHMENTS

4.1 U-VENTS

4.1.1 Standard u-vents are constructed from schedule 40 PVC and are provided with a loose male adapter. This allows the u-vent to be cut to the desired height. A threaded or solvent welded socket fitting can be used.

4.1.2 When installing the u-vent in a PVC solvent weld socket fitting, solvent weld the u-vent with the proper solvent cement in the desired position into a previously installed fitting. If the u-vent is to be used in a threaded fitting, solvent weld the male adapter provided to the u-vent and install the u-vent assembly into a previously installed threaded fitting. Refer to Figure 4.1 for an exploded illustration of this assembly.

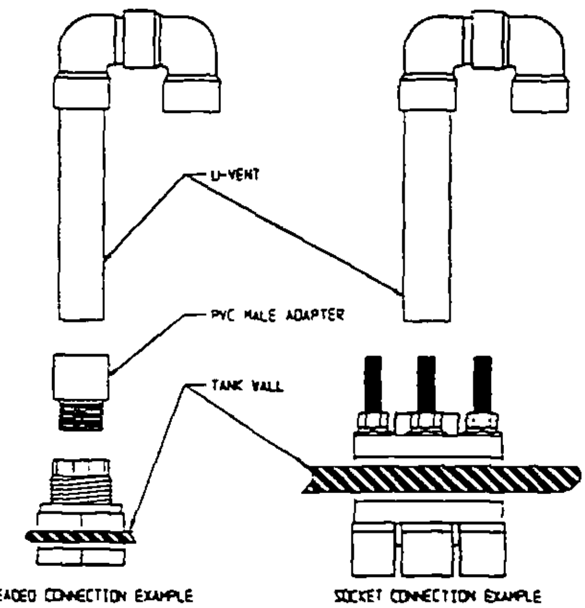


Figure 4.1

4.2 DOWN PIPES - EXTERNAL AND/OR INTERNAL

4.2.1 Down pipes are shipped loose and have been cut to size to meet customer specifications. All down pipes shall be supported at 5 ft. maximum intervals with the support structures provided.

4.2.2 Assemble the piping loosely using Figure 4.2, the guidelines detailed below, and the customer approved tank drawing to ensure all parts are present and cut to meet the customer's requirements. As soon as all parts have been checked, assemble the parts with solvent weld cement and/or threaded connections as shown in Figure 4.2.

4.2.3 Assemble and install support structures as shown in Figure 4.2 (without the saddle clamp cover caps and clips). Make sure the support clamp orientation is correct (with the small width of the wedge toward the top of the tank) and that the plugged support pipes are installed with the plugged end as close to the support fitting as possible. Assemble and install piping as per the customer approved drawing. As piping is being installed on the tank, lock it in place with the saddle clamp cover caps and clips provided (make sure that the sealing o-ring is in the proper position as the pipe is positioned into the saddle support body). Seal all threaded pipe connections with Teflon® pipe sealant and connect solvent weld sockets with solvent cement.

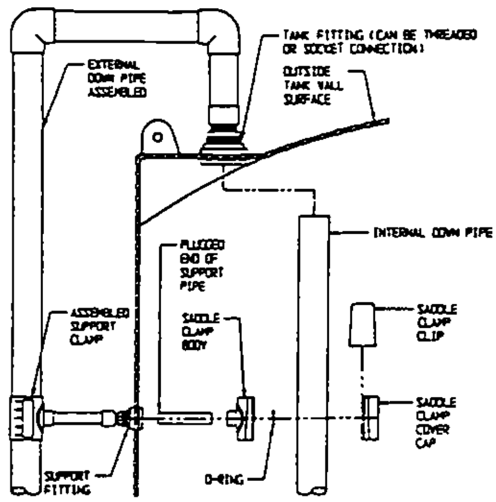


Figure 4.2

4 3 FLEXIBLE SIGHT LEVEL GAGES

4 3.1 Sight level gage assemblies are shipped loose and have been cut to size to meet customer specifications. Sight gages may be ordered with either no valve, 1, 2, or 3 valves. Please refer to the customer approved drawing to determine the number of valves required.

4 3 2 Using the assembly drawings shown in Figure 4.3, verify that all parts are present and assemble the unit per the appropriate drawing Seal all threaded pipe connections with Teflon® pipe sealant. Gallonage decals may be purchased as separate items and customer applied to the tank to assist in indication of tank gallonage. NOTE - Gallonage decals are not available for all tank sizes.

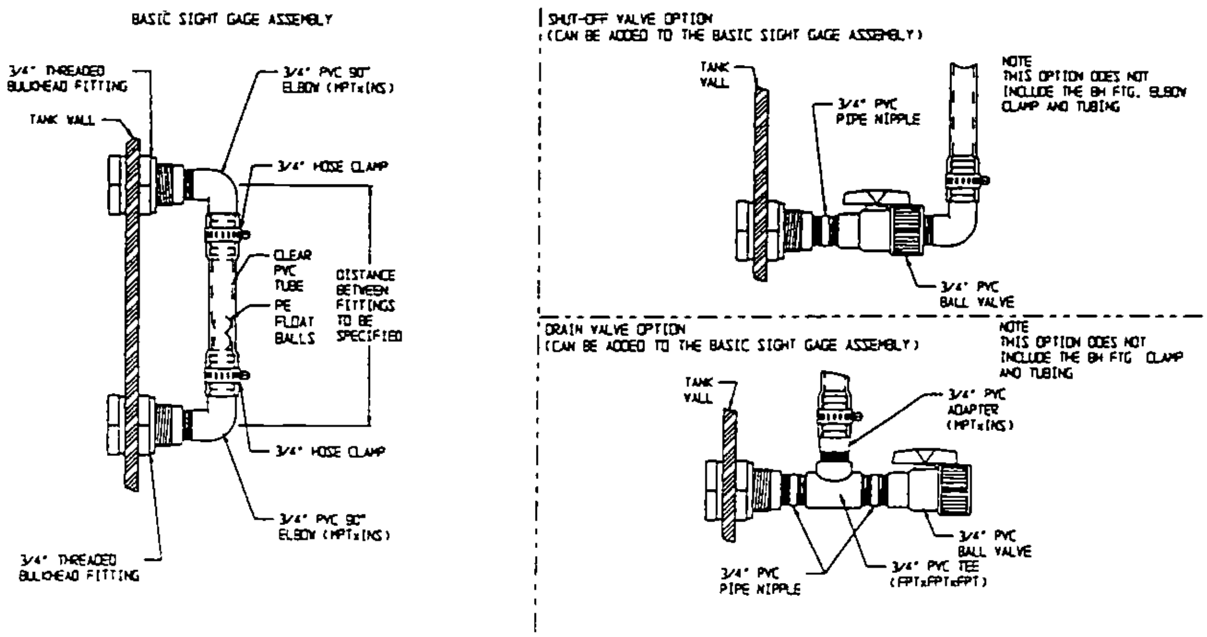


Figure 4 3

685 110.

4.4 REVERSE LEVEL SIGHT GAGE

4.4.1 The component parts (except the rope) have been cut to meet SII and customer specifications. The sight gage shall be supported at 5 ft. maximum intervals with the support structures provided.

4.4.2 Assemble the piping loosely using Figure 4 4, the guidelines detailed below, and the customer approved tank drawing to ensure all parts are present and cut to length. As soon as all parts have been checked, assemble the parts with solvent weld cement and/or threaded connections as shown in Figure 4.4. NOTE - Do not use solvent weld cement on the outside joints indicated in Figure 4.4. SII recommends periodic inspection of the rollers in the tee assemblies and the rope to ensure proper operation of the gage. If it is a requirement to seal these joints, a silicone based caulking should be sufficient.

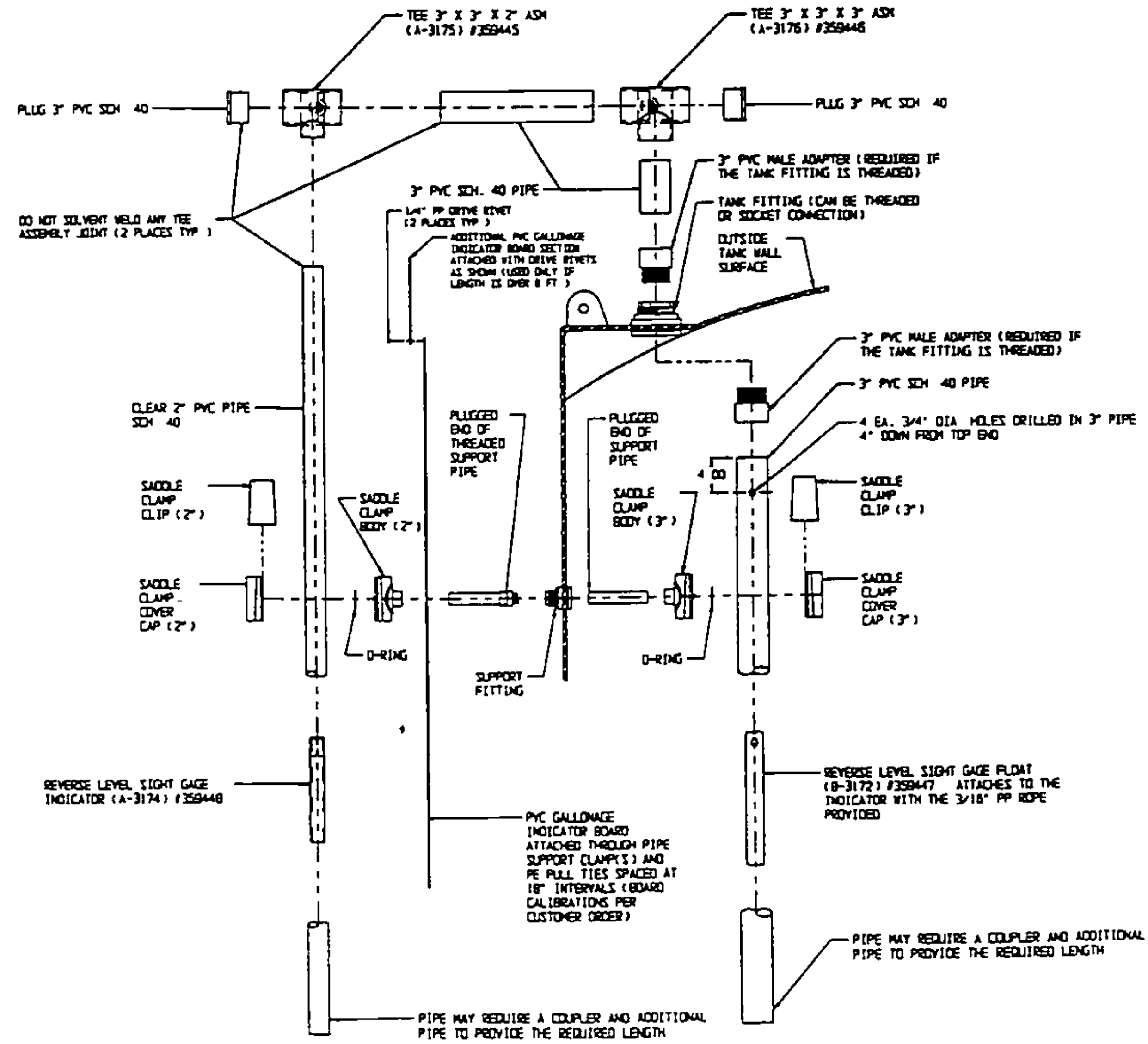


Figure 4 4

4 4 3 Assemble and install the support structures as shown in Figure 4 4 (without the saddle clamp cover caps and clips) Make sure the support clamp orientation is correct (with the small width of the wedge toward the top of the tank) and that the plugged support pipes are installed with the plugged end as close to the support fitting as possible Make sure that the indicator board has

been installed over the outer pipe supports as shown in Figure 4.4. Assemble and install piping as per the customer approved drawing. As piping is being installed on the tank, lock it in place with the saddle clamp cover caps and clips provided (make sure that the sealing o-ring is in the proper position as the pipe is positioned into the saddle support body). Seal all threaded pipe connections with Teflon® pipe sealant and connect solvent weld sockets with the correct solvent cement (except the joints as noted in Figure 4.4).

4.5.4 With the inner and outer tank pipes in place, connect the rope provided to the tank float (This is accomplished by threading the rope through the center hole in the float and out one of the side holes, double knotting the rope, cutting off any excess material and pulling the rope back so the knot holds under the center hole.) and lower it into the inner pipe as shown. Thread the rope through the tee assemblies and the connecting pipe as shown. At this point the float should be at the bottom of the tank, the tee assemblies and connecting pipe should be assembled and sitting off at an angle from the outer clear 2" PVC pipe. With the rope threaded through the outer tee assembly, attach the rope to the indicator in a position parallel with the zero mark on the indicator board. (This is accomplished by threading the rope through the center hole in the indicator, double knotting the rope, checking the indicator position, adjusting as necessary and cutting any excess material protruding from the bottom of the indicator.) Put the indicator into the outer clear 2" PVC pipe while swinging the tee assemblies and connecting pipe into position. With all piping and tee assemblies installed, install the 3" PVC pipe plugs. During the tank hydrotest and first operations of the tank, check the gage for proper level indication and adjust as necessary. NOTE - This is a gallonage indicator and is not intended as an accurate measuring device.

4 5 FLANGE ADAPTERS

4.5 1 Standard flange adapters are constructed from schedule 40 PVC and may be purchased for solvent weld socket fittings or threaded fittings. Flange adapters for threaded fittings are provided with loose male adapter to allow the customer to adjust adapter length and flange position to match the piping at the installation. Refer to Figure 4.5 for an illustration of a flange adapter.

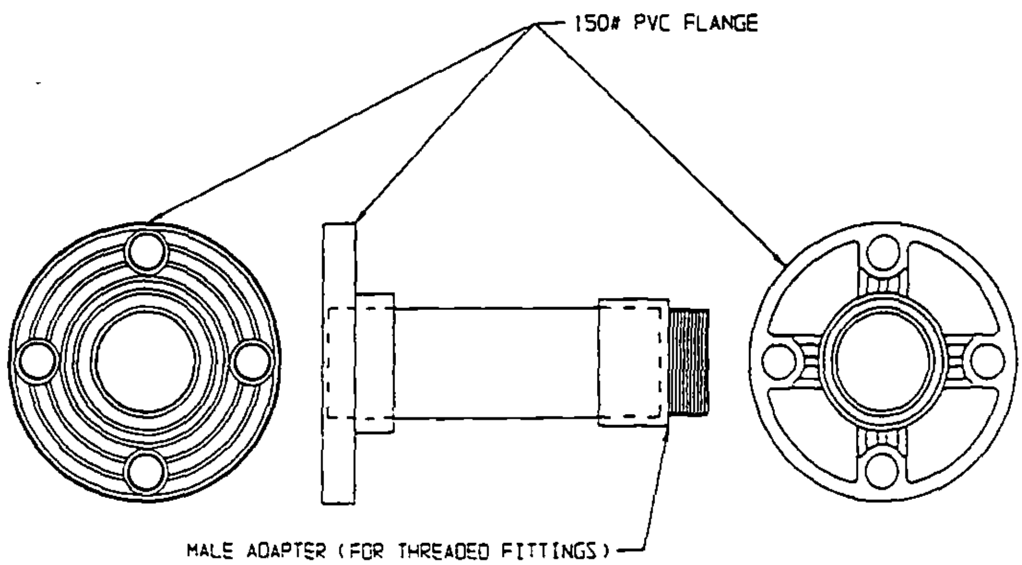


Figure 4.5

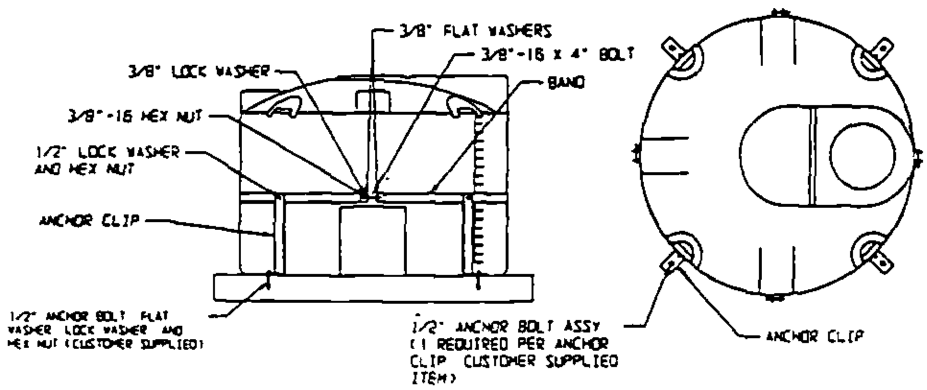
4 5 2 When installing the flange adapter in a PVC solvent weld socket fitting, cut the flange adapter to desired length and solvent weld the flange adapter with the proper solvent cement in the desired position in a previously installed fitting If the flange adapter is to be used in a threaded fitting, install the male adapter into the fitting with Teflon® pipe sealant, cut the flange adapter to the

desired length, and solvent weld the flange adapter to the male adapter in the desired position with the proper PVC solvent cement.

5. TANK ACCESSORIES

5.1 LATERAL RESTRAINT SYSTEM (FLAT BOTTOM TANKS)

5.1.1 The lateral restraint system is designed for tank position restraint on a concrete pad inside of an enclosed building. **It is not designed for wind or seismic restraint capabilities.** Using the assembly drawing and table shown in Figure 5.1, verify that all parts are present.



TANK DIA (IN.)	QUANTITY REQUIRED: BAND 44 IN	BAND 48 IN	ANCHOR CLIPS	3/8"-16 X 4" BOLTS AND HEX NUTS	3/8" FLAT WASHERS	1/2" HEX NUTS AND FLAT WASHERS
48	0	3	3	3	6	3
64	0	4	4	4	8	4
86	5	0	5	5	10	5
90	3	3	6	6	12	6
102	7	0	7	7	14	7
120	4	4	8	8	16	8
137	4	5	9	9	18	9
142	0	9	9	9	18	9

Figure 5.1

5.1.2 Locate the tank on the concrete pad as desired. Lay out the bands around the tank (alternate long bands and short bands if both lengths are provided) with the studs and angle ends sticking out away from the tank. Fasten the bands together with the 3/8" - 16 x 4" hex head bolts as shown in the drawing. Raise the bands 17" and loosely install the anchor clips using the 1/2" - 13 hex nuts and 1/2" washers provided. Tighten the 3/8" - 16 x 4" hex head bolts to remove band looseness. Mark the slot locations of the anchor clips, remove the clips, and install the required number of 1/2" anchor bolts. Anchor bolts are not provided by the manufacturer and must be purchased by the customer.

5.1.3 Replace the anchor clips and secure the clips to both bands and the concrete pad. Do not over tighten the bands to the tank. The band tension should only remove looseness and not cause any tank deflection.

5.2 WIND/SEISMIC TANK RESTRAINT SYSTEM (FLAT BOTTOM TANKS)

5.2.1 The wind/seismic tank restraint system is designed for tank restraint on an appropriate concrete pad under 110 MPH wind or seismic zone 4 conditions. Using the assembly drawing and table shown in Figure 5.2, verify that all parts are present.

5.2.2 Locate the tank on the concrete pad as desired. Lay out all anchors required (4 or 8) equally spaced, (4 anchors must be directly below the tank tie down locations). Make sure all anchors are located next to the tank with the 2 ea. eye bolt holes of the anchor on top of the weldment and

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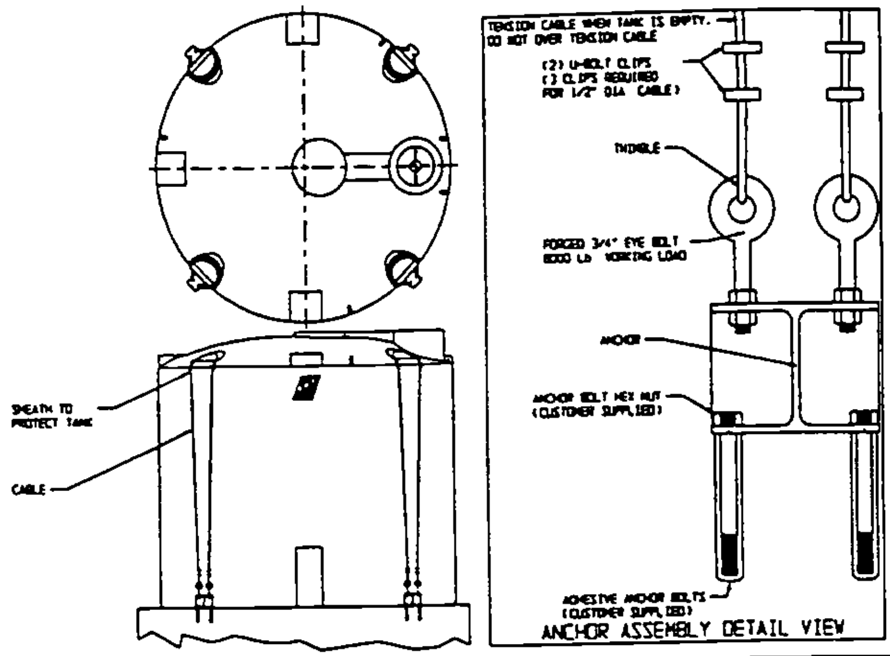
685 113

the plate face of the anchor weldment located next to the tank. Mark all the anchor bolt locations, remove the anchors and install the required Hilti adhesive model HVA anchor bolts as specified by the assembly drawing and the SII seismic restraint drawings B-2686A through B-2688A. These anchor bolts are not provided by the manufacturer and must be purchased by the customer.



TANK SIZE (GALLONS)	TANK DIAMETER (INCHES)	1.5 SPECIFIC GRAVITY FLUID				1.9 SPECIFIC GRAVITY FLUID			
		ANCHOR REQUIRED	ANCHOR QUANTITY	ANCHOR BOLT MATERIAL	CABLE DIA (INCHES)	ANCHOR REQUIRED	ANCHOR QUANTITY	ANCHOR BOLT MATERIAL	CABLE DIA (INCHES)
400	45	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
550	48	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
550	64	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
850	48	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
1100	64	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
1100	85	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
1500	85	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
1550	64	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
1650	85	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
2000	90	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
2500	90	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
3000	90	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
3000	102	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
3800	90	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
4400	90	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
4400	120	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"
4900	102	A-2678	4 EA	4 EA 1/2" DIA HAS STANDARD	1/4"	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	3/8"
4900	90	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	3/8"
5500	90	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	3/8"	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
5500	120	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
5800	142	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
6000	102	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
6200	120	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
6500	120	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
7000	142	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/2"
7500	102	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	3/8"	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
8000	120	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
8750	142	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
9500	120	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	8 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
10500	142	A-2679	4 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	8 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
12500	142	A-2679	8 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	8 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
15000	142	A-2679	8 EA	4 EA 3/4" DIA HAS STANDARD	1/4"	A-2679	8 EA	4 EA 3/4" DIA HAS STANDARD	1/4"
16500	142	A-2679	8 EA	4 EA 3/4" DIA HAS STANDARD	3/8"	A-2679	8 EA	4 EA 3/4" DIA HAS STANDARD	3/8"

Figure 5 2

685 114

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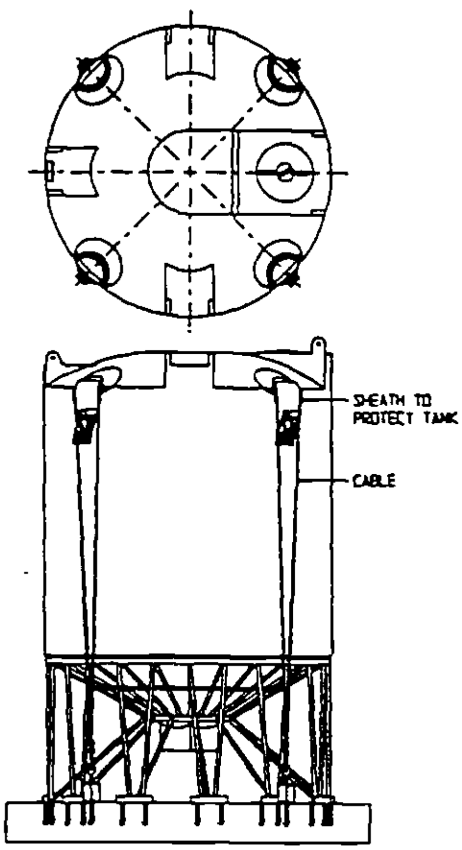
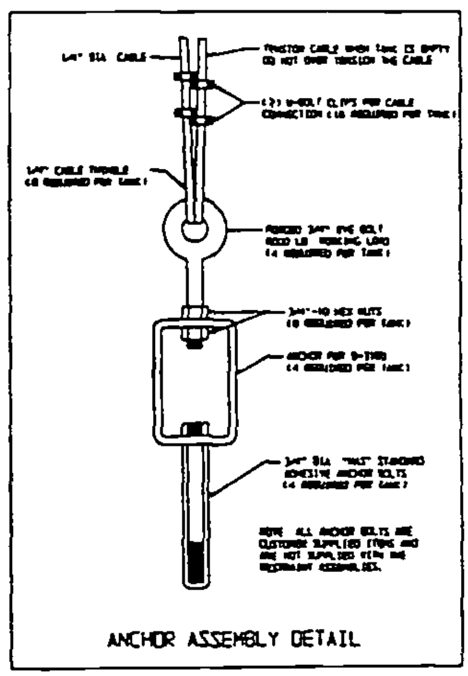
5.2.3 Replace the anchors and secure the anchors to the concrete. Install the 3/4" eyebolts loosely as shown by the drawing. Fasten the tank to the concrete pad with the required cable (make sure the cable sheath is on the cable and located around the lug locations) as shown by the assembly drawing utilizing the cable thimbles and clamps provided. Tension the cable before filling the tank to remove cable looseness. Do not over-tension the cables as this may cause tank damage. The cable tension will change with tank loading and temperature changes - DO NOT re-tension the cables.

5.3 WIND/SEISMIC TANK RESTRAINT SYSTEM (CONE BOTTOM TANKS)

5.3.1 The wind/seismic tank restraint system is designed for cone bottom tank restraint on an appropriate concrete pad under 110 MPH wind or seismic zone 4 conditions using a SII cone stand for proper tank support. Using the assembly drawing and table shown in Figure 5.3, verify that all parts are present.





TANK SIZE (GALLONS)	TANK DIAMETER (INCHES)	1.9 SPECIFIC GRAVITY FLUID STAND REQUIRED	1.9 SPECIFIC GRAVITY FLUID STAND ANCHOR BOLTS REQUIRED
500	64	78800	8 EA 1/2" DIA "HAS" STANDARD
500	86	79000	8 EA 1/2" DIA "HAS" STANDARD
1000	64	78800	8 EA 1/2" DIA "HAS" STANDARD
1400	86	79000	8 EA 1/2" DIA "HAS" STANDARD
1500	64	78800	8 EA 1/2" DIA "HAS" STANDARD
1650	86	78800*	8 EA 1/2" DIA "HAS" STANDARD
2000	90	79300	24 EA 3/4" DIA "HAS" STANDARD
2500	90	79300	24 EA 3/4" DIA "HAS" STANDARD
2600	90	79400	24 EA 3/4" DIA "HAS" STANDARD

*NOTE 79000 STAND ACCEPTABLE FOR SPECIFIC GRAVITIES UNDER 1 7

TANK SIZE (GALLONS)	TANK DIAMETER (INCHES)	1.9 SPECIFIC GRAVITY FLUID STAND REQUIRED	1.9 SPECIFIC GRAVITY FLUID STAND ANCHOR BOLTS REQUIRED
3000	90	79300	24 EA 3/4" DIA "HAS" STANDARD
3300	90	79300	24 EA 3/4" DIA "HAS" STANDARD
4100	90	79500	24 EA 3/4" DIA "HAS" STANDARD
4400	90	79800	24 EA 3/4" DIA "HAS" STANDARD
5500	90	79800	24 EA 3/4" DIA "HAS" STANDARD
5800	90	79900	24 EA 3/4" DIA "HAS" STANDARD
6000	142	79500	24 EA 3/4" DIA "HAS" STANDARD
6500	90	79800	24 EA 3/4" DIA "HAS" STANDARD
7400	142	79500	24 EA 3/4" DIA "HAS" STANDARD
11500	142	79500	24 EA 3/4" DIA "HAS" STANDARD

Figure 5 3

5.3.2 Locate the tank and stand on the concrete pad as desired. Lay out the four anchors provided directly below the tank tie down locations. Make sure all anchors are located so the hole in the anchor aligns with the tank wall. Mark all the anchor bolt locations (stand and anchor positions), remove the stand and anchors and install the required Hilti adhesive model HVA anchor bolts as specified by the assembly drawing and the SII seismic restraint drawing B-3182. These anchor bolts are not provided by the manufacturer and must be purchased by the customer.

5.3.3 Replace the stand and anchors and secure to the concrete pad. Install the 3/4" eyebolts loosely as shown by the drawing. Fasten the tank to the concrete pad with the required cable (make sure the cable sheath is on the cable and located around the lug locations) as shown by the assembly drawing utilizing the cable thimbles and clamps provided. Tension the cable <u>before</u> filling the tank to remove cable looseness. Do not over-tension the cables as this may cause tank damage. The cable tension will change with tank loading and temperature changes - <u>DO NOT</u> re-tension the cables.

5.4 STEEL LADDERS

5.4.1 Steel ladders are designed in accordance with OSHA 1910.27 and are to be mounted next to the tank on a concrete pad at the same elevation as the bottom of the tank. The ladder mounting system is designed to allow for tank expansion and contraction due to temperature and loading changes. Using the assembly drawing and table shown in Figure 5.4, verify that all parts are present and assemble accordingly.

NOTE: **This ladder is provided for tank inspection only. At no time should the operator step off this ladder onto the tank unless stepping onto an approved work platform with guard rails or utilizing some other approved safety device.** Proper safety equipment (i.e guard rails, safety harness, etc) must be used to step onto the tank. Consult applicable regulations to determine proper equipment for other than inspection work.

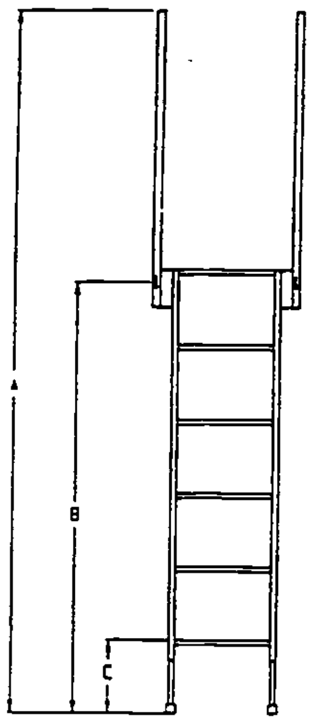
5 4.2 Insert two pivoting foot assemblies into the rail tubes and fasten with 1 ea. 1/4" bolt, lock washer and hex nut provided at the height shown in the drawing. Attach the two pivoting attachment arms to the ladder using 1 ea. 1/2"-13 x 2" hex head bolt and 2 ea. 1/2" - 13 hex nuts Double nut each bolt by tightening the first nut to 85 ft. - lbs. of torque and then jamming the second nut to the first nut by holding the first nut and tightening the second to 85 ft. - lbs. of torque. Position the ladder on the tank and attach the top pivoting attachment arms to the tank with the ladder attachment tube and cotter pin provided (see Figure 5.4). Position the ladder parallel with the side of the tank and mark the 1/4" anchor bolt locations. Install appropriate 1/4" anchor bolts and attach the bottom of the ladder to the concrete pad. Anchor bolts are not provided by the manufacturer and must be purchased by the customer.

5.4 3 Ladder rung height may be adjusted by the customer if desired by using another mounting hole for the pivoting foot assembly However, the bottom rung height must never exceed 12" due to OSHA requirements. Also do not adjust the ladder too high, since lower ladder settings are best for ladder operation.

5 5 STEEL LADDER CAGES

5 5 1 Using the assembly drawing shown in Figure 5.5 and the instructions in section 5.5.2, verify that all parts are present and assemble accordingly These cages are designed for use only with the SII steel ladder design Cages are required for ladders used to ascend to heights exceeding 20 ft.

685 116



TANK SIZE	TANK P/N	A	B	C	CAGE
2000 X 90	505XXX	126.0	84 0	12	NO
2500 X 90	509XXX	145.0	103.0	7	NO
3000 X 90	513XXX	162.0	122.0	9	NO
3000 X 102	741XXX	135 0	93.0	12	NO
3900 X 90	519XXX	198.0	158.0	12	NO
4400 X 90	521XXX	219.0	178.0	9	NO
4400 X 120	8200XX	138.0	96.0	12	NO
4500 X 102	742XXX	183.0	139.0	9	NO
4900 X 90	548XXX	239.0	197.0	5	NO
5500 X 90	702XXX	258.0	215.0	12	NO
5500 X 120	700XXX	159.0	119.0	9	NO
5600 X 142	525XXX	126.0	85.0	12	NO
6000 X 102	743XXX	227.0	183.0	5	NO
6200 X 120	8220XX	179.0	135.0	5	NO
6500 X 120	714XXX	181.0	140.0	7	NO
7000 X 142	530XXX	147.0	105.0	9	NO
7500 X 102	744XXX	270.0	228.0	12	NO
8500 X 120	740XXX	222 0	182.0	12	NO
8750 X 142	536XXX	169 0	129.0	7	NO
9500 X 120	745XXX	243.0	203.0	9	NO
10500 X 142	533XXX	193.0	152 0	7	NO
12500 X 142	535XXX	222.0	181.0	12	NO
15000 X 142	537XXX	258 0	217.0	12	NO
16500 X 142	538XXX	282 0	240 0	12	YES

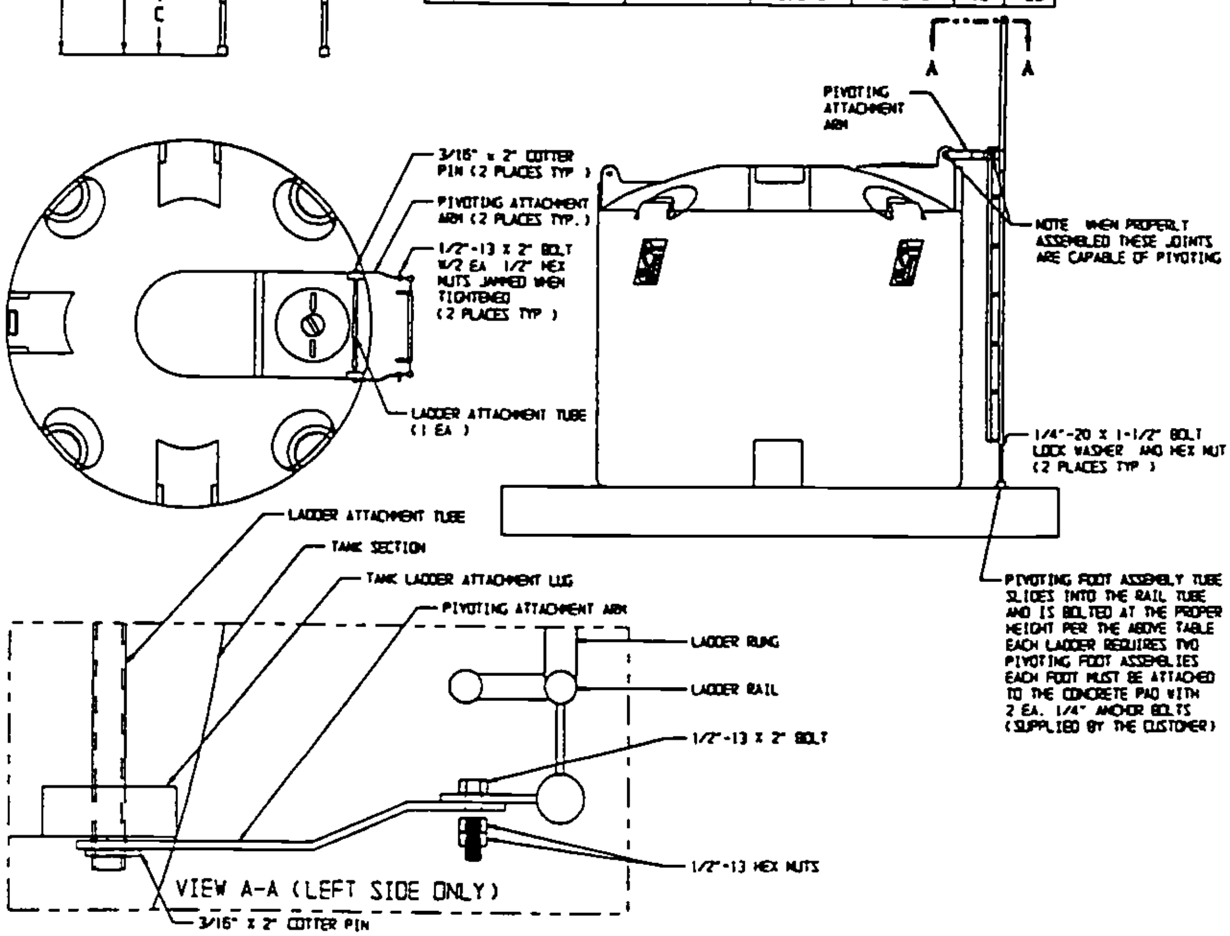


Figure 5 4

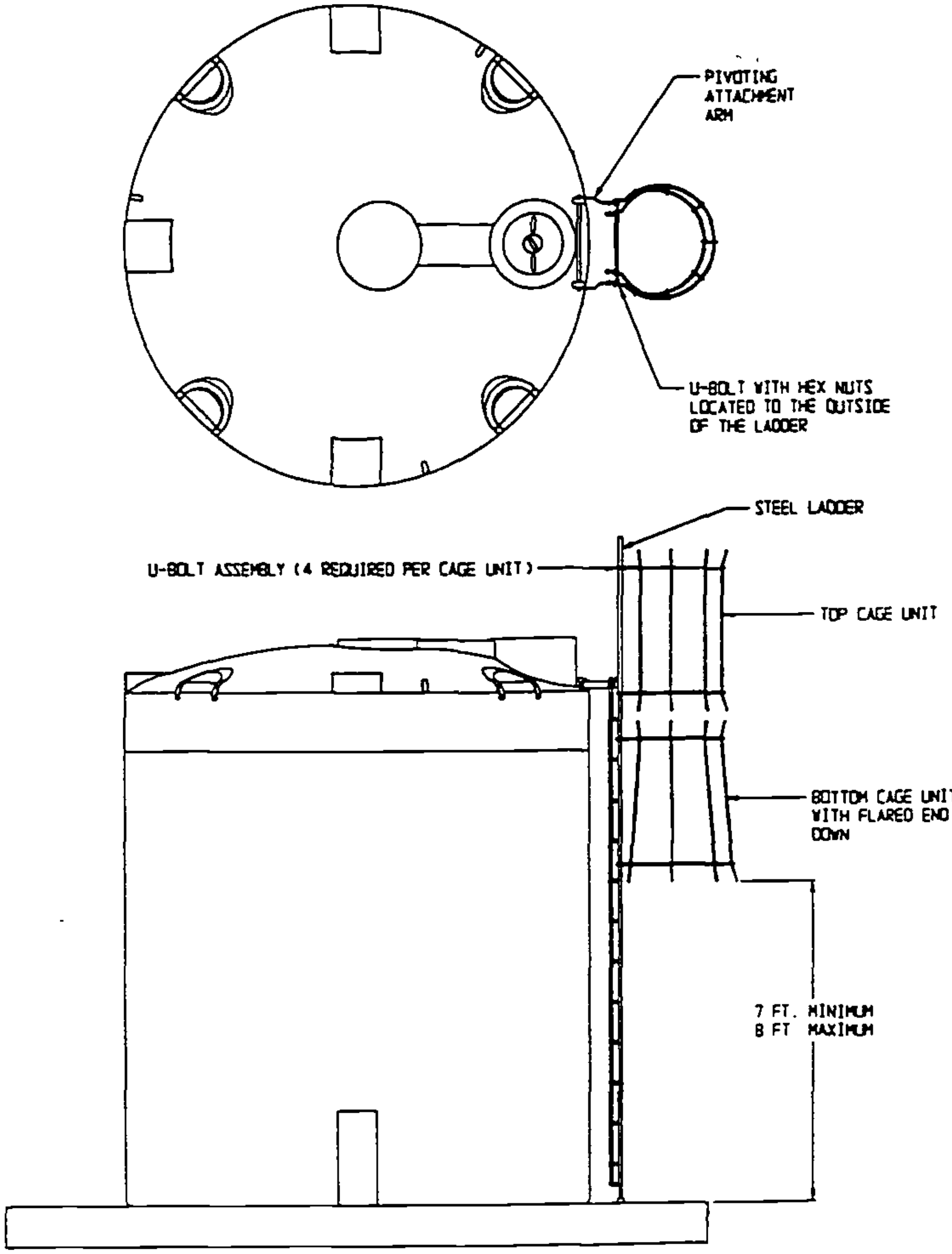


Figure 5.5

NOTE. *Assembly is easier if the cages are installed* on the ladder before the ladder installation to the tank.

5 5.2 Install the cages loosely using the u-bolts provided starting with the top cage unit (4 ft unit with a larger bolt pattern) The bottom cage unit must have a larger diameter at the bottom than at the top of the unit and the bottom edge of the unit be located a minimum of 7 feet and a maximum of 8 feet above the ground When the cage units have been properly located and spaced evenly, tighten the u-bolts securely

5.6 FRP LADDERS (up to 300" height)

5.6.1 FRP ladders are designed in accordance with OSHA 1910.27 and are to be mounted next to the tank on a concrete pad at the same elevation as the bottom of the tank. The ladder mounting system is designed to allow for tank expansion and contraction due to temperature and loading changes. Using the assembly drawing and table shown in Figure 5.6, verify that all parts are present and assemble accordingly.

NOTE: This ladder is provided for tank inspection only. At no time should the operator step off this ladder onto the tank unless stepping onto an approved work platform with guard rails or utilizing some other approved safety device. Proper safety equipment (i.e. guard rails, safety harness, etc.) must be used to step onto the tank. Consult applicable regulations to determine proper safety equipment.

5.6.2 Attach the stainless steel top pivoting attachment arms to the ladder using the 1/2" bolt and 3/4" bushing assemblies (2 required) as shown in Figure 5.6. Position the ladder on the tank and attach the top pivoting attachment arms to the tank with the ladder attachment tube and cotter keys provided (see assembly drawing). Position the ladder parallel with the side of the tank and mark 4 ea. 5/8" anchor bolt locations. Install appropriate 5/8" anchor bolts and attach the bottom of the ladder to the concrete pad. Anchor bolts are not provided by the manufacturer and must be purchased by the customer.

TANK SIZE	TANK P/N	A	B	SPACER
2000 x 90	505xxx	126.0	85.5	NO
2500 x 90	509xxx	145.0	105.0	NO
3000 x 90	513xxx	166.0	122.0	NO
3000 x 102	741xxx	137.0	93.0	NO
3900 x 90	519xxx	202.0	158.0	NO
4400 x 90	521xxx	219.0	178.0	NO
4500 x 102	742xxx	182.0	138.0	NO
4900 x 90	548xxx	238.0	197.0	NO
5500 x 90	702xxx	258.0	214.0	NO
5500 x 120	700xxx	160.0	120.0	YES
5600 x 142	525xxx	126.0	87.0	NO
6000 x 102	743xxx	227.0	183.0	NO
6500 x 120	714xxx	181.0	140.0	YES
7000 x 142	530xxx	147.0	106.0	NO
7500 x 102	744xxx	270.0	226.0	NO
8750 x 142	536xxx	170.0	130.0	NO
10500 x 142	533xxx	193.0	152.0	NO
12500 x 142	535xxx	222.0	181.0	NO
15000 x 142	537xxx	258.0	217.0	NO

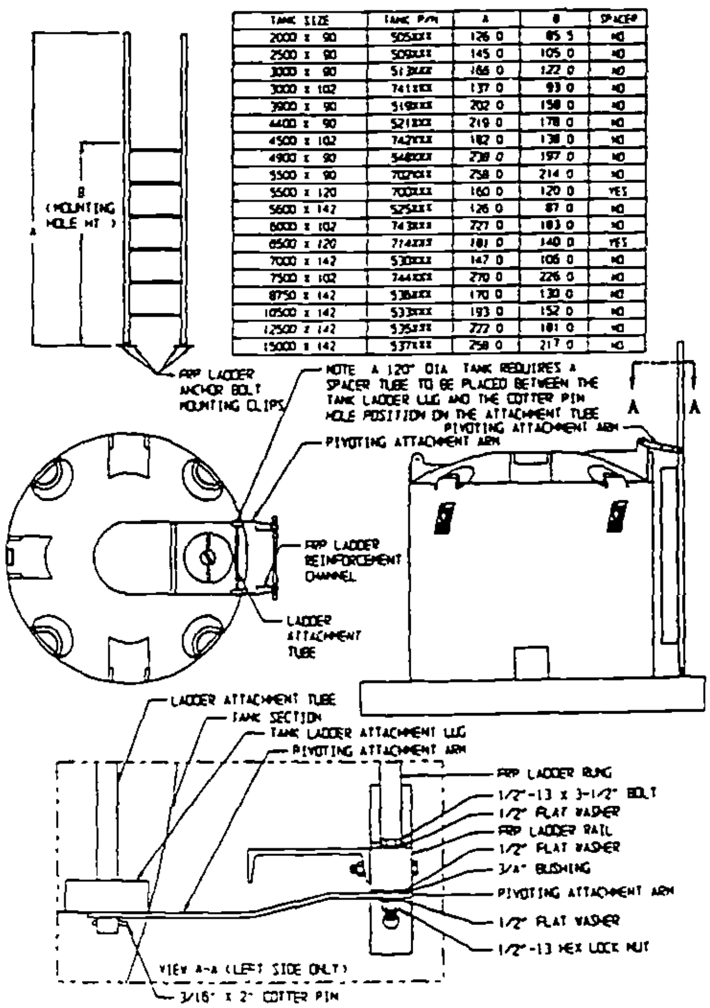


Figure 5.6

5.7 FRP LADDER CAGES

5.7.1 Using the assembly drawing shown in Figure 5.7 and the instructions in section 5.7.2, verify that the correct number of fasteners have been shipped to attach the FRP cage unit. These cages are designed for use only with the SII FRP ladder design. Cages are required for ladders used to ascend to heights exceeding 20 ft.

NOTE. Assembly is easier if the cage unit is installed on the ladder before ladder installation.

5.7.2 Position the cage unit on the ladder with the flared end toward the ladder base. Attach the cage to the ladder using the 3/8" stainless steel bolts provided (4 bolt assemblies per cage hoop).

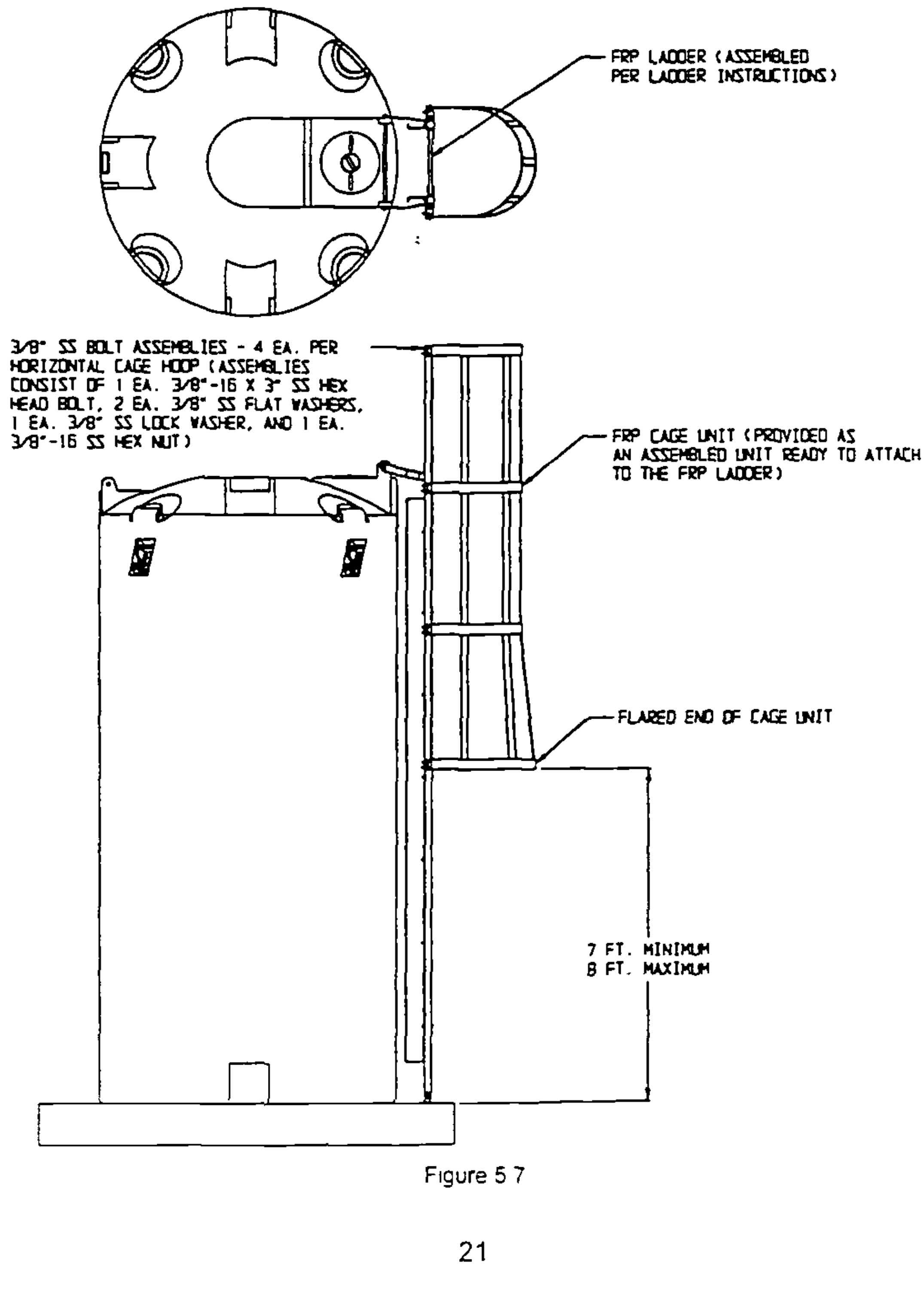


Figure 5 7

5.8 HORIZONTAL TANK SUPPORT SADDLES

5.8.1 Horizontal tank support saddles are designed to provide adequate support for SII horizontal tanks (up to 500 gallon size). Additional structural attachments may be necessary depending upon the specific application. Use the assembly drawing shown in Figure 5.8 to assist in part identification and assembly.

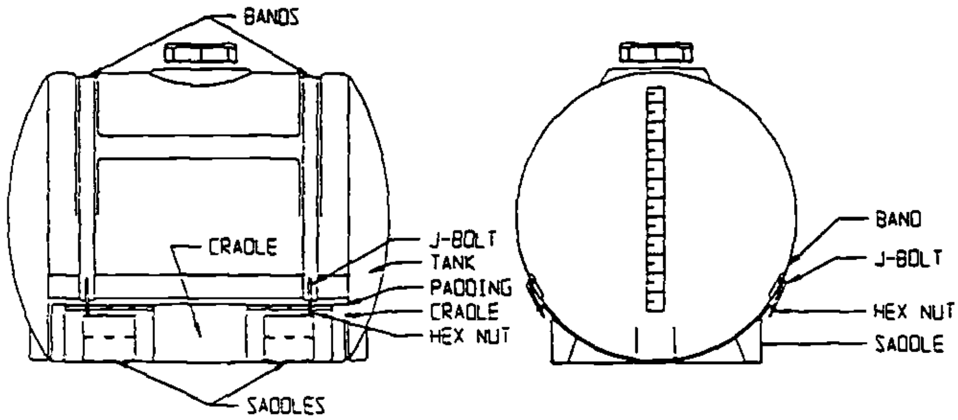


Figure 5.8

5.8.2 Position the saddle(s) provided in the desired location. If two saddles are required, position the saddles as close to the end of the cylindrical part of the tank as possible lining up a band mounting hole with the center of the band location on the tank. Place a galvanized tank cradle on the saddles if more than one saddle is required (this is an optional item that must be used for liquids with a specific gravity greater than or equal to 1.0 or for elevated tank applications). Place the padding provided over the saddle locations on top of the cradle (if a cradle is not used, place directly on the saddle(s)) Place the tank on top of the padding and adjust the position of the components as necessary. Install bands with j-bolts provided and tension firmly. Tension the bands, but not enough to cause visible tank deflection. Mount saddle/tank assembly to structural supports as required per the application. Recheck band tension after the tank has been filled.

5 9 HORIZONTAL TANK SKIDS

5.9.1 Horizontal tank skids are designed to provide adequate support for SII horizontal tanks (200-1000 gallons) and a structural support frame which provides easy attachment for a variety of stationary applications Use the assembly drawing shown in Figure 5.9 to assist in part identification and assembly.

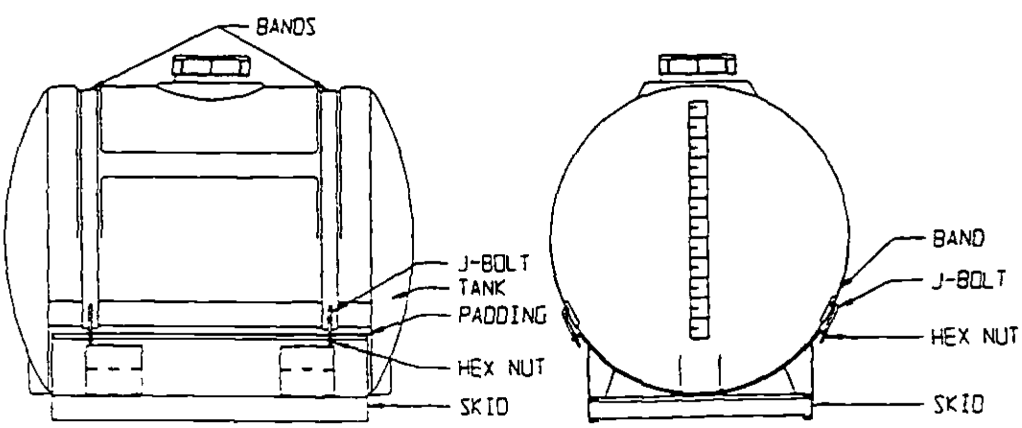


Figure 5 9

5.9.2 Position the skid provided in the desired location and attach as necessary for the application. Place the pads provided on the cradle of the skid lined up with band mounting hole locations. Place the tank on top of the padding. Install bands with j-bolts provided and tension firmly. Tension the bands, but not enough to cause visible tank deflection. Recheck band tension after the tank has been filled.

5.10 HORIZONTAL LEG TANK SKIDS

5.10.1 Horizontal leg tank skids are designed to provide adequate support for SII horizontal leg tanks (750-1685 gallons) and a structural support frame which provides easy attachment for a variety of stationary applications. Use the assembly drawing shown in Figure 5.10 to assist in part identification and assembly.

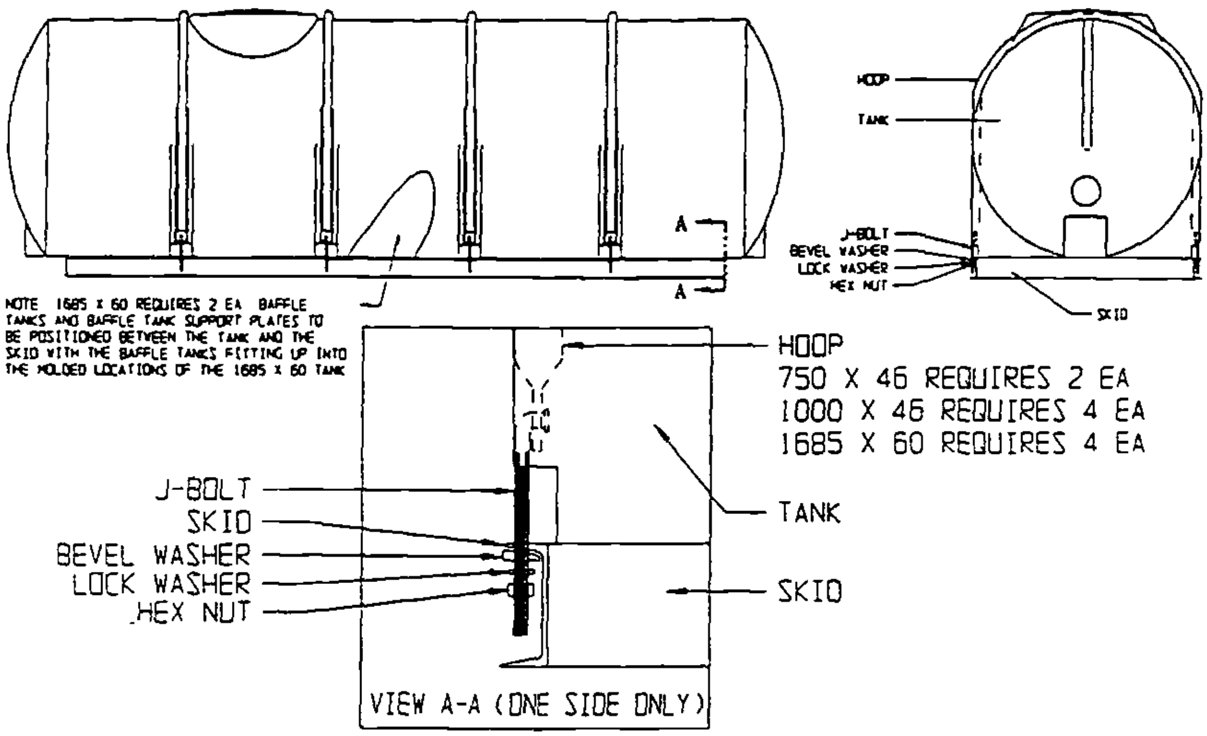


Figure 5.10

5.10.2 Position the skid provided in the desired location and attach as necessary for the application. Position the tank on the skid with the legs centered over the hoop mounting holes in the top of the skid (NOTE. the 1685 x 60 horizontal leg tank requires 2 ea. baffle tanks and baffle tank support plates to be positioned between the tank and the skid with the baffle tanks fitting up into the molded locations of the 1685 x 60 tank)

5 10 3 With one person on each side of the tank, insert J-bolts into the hoop holes and lift the hoop into position directly above the tank legs. Spread the hoop slightly while sliding the hoop (centered in the pipe guide channel formed into the tank legs) onto the tank. Insert the J-bolts into the proper holes in the top of the skid. Install the bevel washer, lock washer, and hex nut on each of the J-bolts loosely Do not tighten the hex nuts yet. See view A-A shown in Figure 5.10 for an illustration of the loosely assembled J-bolt/hoop assembly

5 10 4 Repeat the procedure as detailed in section 5.10 3 for each of the remaining hoops required When all hoops have been loosely installed, check the tank and hoop alignment to make sure the

685 122

placement is correct. When proper alignment has been established, start tightening the hex nuts on each hoop. Tighten both sides of the hoop equally until the top of the hoop is tight all the way around the top of the tank and proper tension is obtained. Proceed to the next hoop and repeat the tightening procedure until all of the hoops have proper tension. Recheck the hoop tension after the tank has been filled.

5.11 EQUIPMENT PLATFORMS (48", 64", 86", 90", AND 142")

5.11.1 Equipment platforms are designed to provide structural support for tank fittings, piping, mixers, etc. The platforms relocate the load caused by tank accessories to the tank wall for maximum tank support. Tanks with diameters of 86" or less have equipment platforms with a rated load capacity of 400 lbs. Tanks with diameters of 90" or more have equipment platforms with a rated load capacity of 600 lbs. Refer to the assembly drawing shown in Figure 5.11 for assistance in part identification and assembly information.

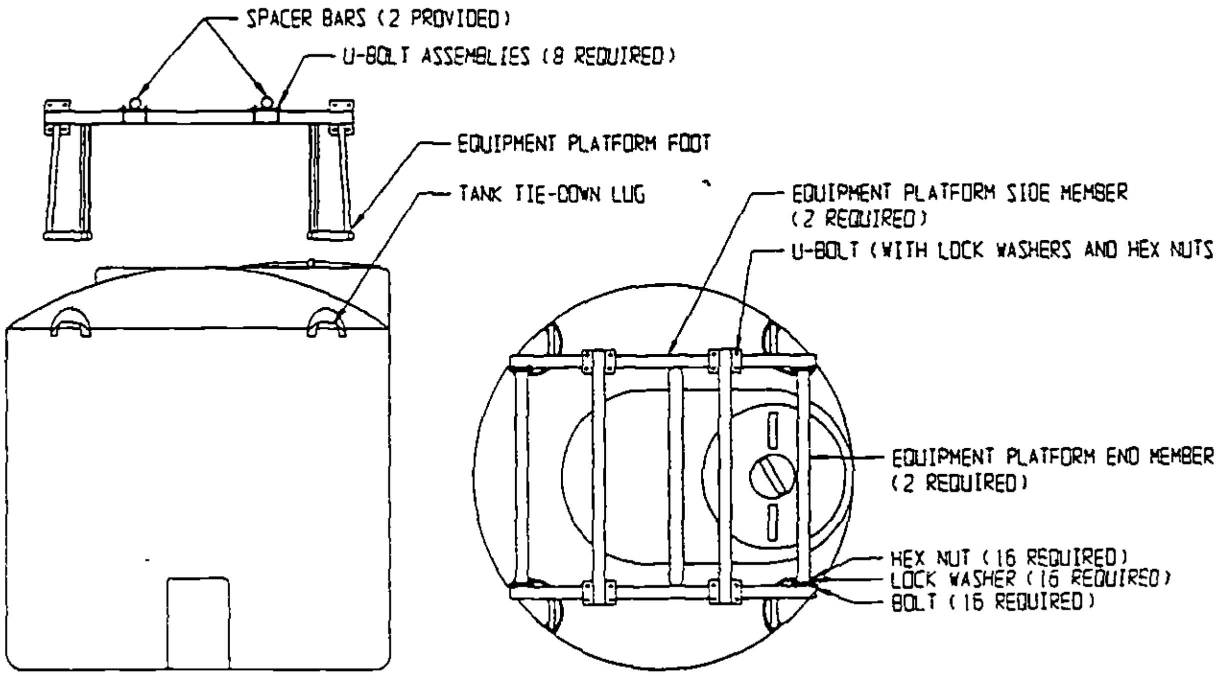


Figure 5.11

5.11.2 Position the equipment platform structural components as shown in the assembly drawing on the ground. Using the fasteners provided, assemble the equipment platform and tighten the fasteners on the ground. When all fasteners have been properly installed, position the equipment platform on the tank with appropriate lifting equipment (when properly installed the platform feet should be locked behind the tank tie-down lugs). Using appropriate safety equipment, position the spacer bars appropriately to connect the tank equipment requiring support to the spacer bars and tighten U-bolts to secure the spacer bars in place. Other support pieces may be necessary to connect the tank equipment to the spacer bars and will have to be provided by the customer for the specific application.

5.12 EQUIPMENT PLATFORMS (102" AND 120")

5.12.1 Equipment platforms are designed to provide structural support for tank fittings, piping, mixers, etc. The platforms relocate the load caused by tank accessories to the tank wall for maximum tank support. These equipment platforms have a rated load capacity of 600 lbs. Refer to the assembly drawing shown in Figure 5.12 for assistance in part identification and assembly information.

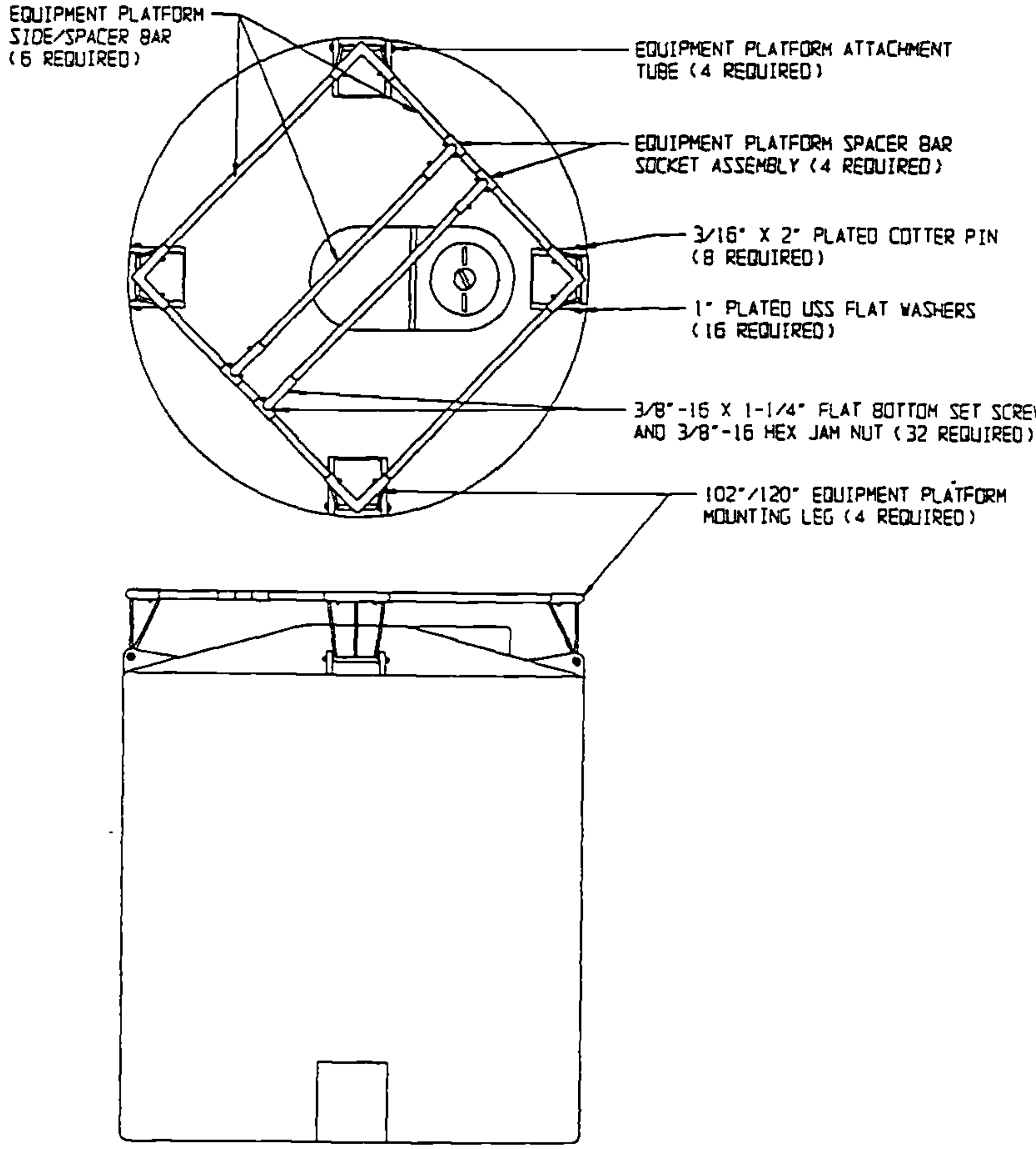


Figure 5.12

5 12.2 Position the equipment platform structural components as shown in the assembly drawing on the ground. Using the set screws provided, assemble the equipment platform and lightly lock the tubes in place. When all fasteners have been properly installed, position the equipment platform on the tank with appropriate lifting equipment and secure one mounting leg to one of the tank's lifting lug sets with 1 ea attachment tube, 4 ea 1" flat washers, and 2 ea 3/16" x 2" plated cotter pins Loosen the set screws and slide the other mounting legs into position. Secure each of the mounting legs with attachment tubes, washers, and cotter pins as stated previously. Center the side/spacer bars within the tube socket joints and position as necessary Tighten all of the set

screws firmly and jam with the hex jam nuts provided Other support pieces may be necessary to connect the tank equipment to the spacer bars and will have to be provided by the customer for the specific application.

5 13 CONE BOTTOM TANK STANDS

5 13 1 Cone bottom tank stands are designed specifically for use with SII cone bottom tanks (500 to 13,000 gallons) to provide support necessary for proper tank operation. The stands are provided as one piece welded units for minimal assembly requirements.

5 13 2 Position the cone stand provided in the desired location on a properly designed concrete pad Stand mounting holes have been provided to secure the structure as required depending upon the tank application. (Consult site engineer for anchoring requirements.) Position the tank in the stand and complete the tank installation as necessary.

5.14 CONE BOTTOM TANK STAND EXTENSIONS

5 14.1 Cone bottom tank stand extensions are designed specifically for use with SII cone bottom tank stands. The extensions are provided in 20" and 40" welded units and are used to increase cone bottom tank clearance 20" or 40".

5 14.2 Install the extensions onto the cone stand legs with the bolt assemblies provided. Tighten bolts to 300 ft -lbs of torque With the extensions in place, proceed with the cone stand installation as previously described

5 15 HEATED TANKS

5 15.1 Heated tanks are insulated with a minimum of 2" of 2-3 lb /ft.^{3} polyurethane foam material with an "R" valve of 8 33/in The insulation is sealed with 2 coats of acrylic latex mastic. Although this appears to be a tough, resilient covering, it can be easily torn or broken if the tank is not properly transported. **Use only carpeted and padded equipment to move an insulated tank.** Do not allow the tank to drop or roll on rough surface as this may damage the insulation.

5 15 2 Heated tanks are equipped with at least 1 control box with maintenance temperature and over-limit temperature settings. The maintenance temperature setting should be set at the desired maintenance temperature. The over-limit temperature setting should be adjusted to 10 degrees above the desired maintenance temperature. The maximum temperature the over-limit control should be set to is 140° F for crosslinked polyethylene tanks and 130° F for high density linear polyethylene tanks Be sure to check tank material type and design before setting any control temperatures over 100° F. It is best to keep the tank at the lowest temperature necessary to accomplish the desired objective. The Figure 5.13 on the next page shows a standard 110 VAC control box front cover with the control functions shown. This control box has calibration functions for the temperature probes. The control box is factory calibrated and should not need recalibrated If there are any questions about control box calibration, consult the factory Figure 5 14 shows a schematic of the terminal connections possible located under the control box front cover The terminals available for customer connection are. line in, over-limit alarm relay, and low-limit alarm relay. There are other control boxes available with different functions not detailed in these instructions Please consult the factory with questions regarding other types of control boxes available Refer to the control box instructions and schematics sent with each tank for further details.

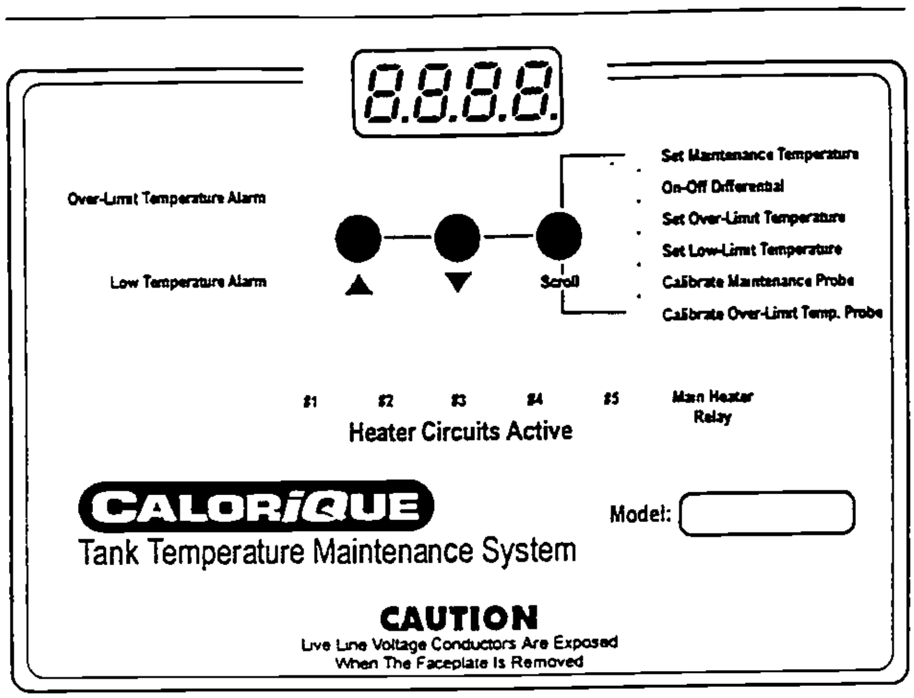


Figure 5.13

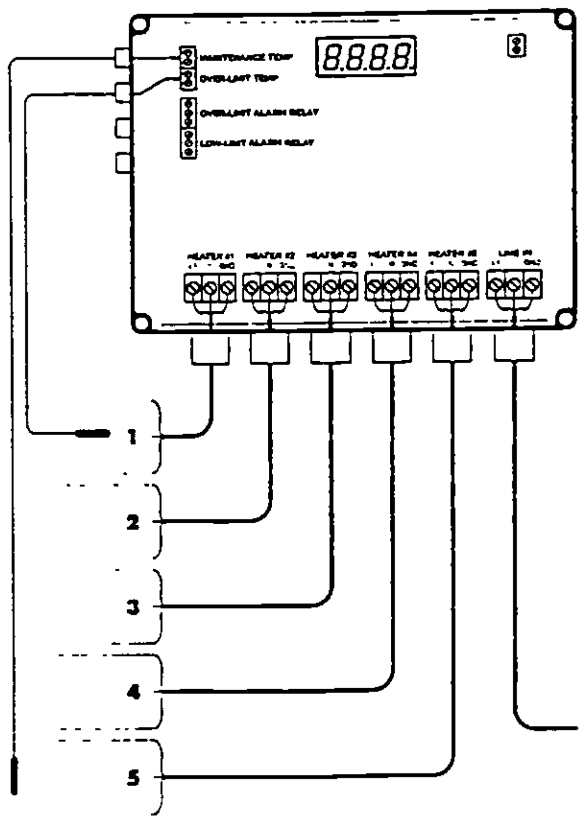


Figure 5 14

6. TANK MAINTENANCE

6.1 TANK INSPECTION

6.1.1 Simple periodic inspections of the tank installation can prevent problems and chemical loss from occurring Inspection intervals should be consistent with site usage (the more times liquid is processed through the tank site, the more frequent the inspections). The checking procedure should be as follows:

1. Inspect the tank for physical damage such as cuts, impacts, cracks, swelling, softening of tank walls, and stress cracks (caused by long term exposure to environmental conditions and stress). NOTE. A "Test Your Tank Kit" may be purchased for stress crack analysis through the Customer Service Department at SII.
2. Inspect the fittings for broken parts, cracks, wear marks, or other signs of potential leaks.
3. Inspect gaskets for deterioration. Look for discoloration, bulges, checking or crazing All of these symptoms could indicate potential failure.
4. Inspect any valves and/or pumps that may be connected to the tank. Also inspect the hoses and connections for any signs of wear.

7. SII PRODUCT POLICY STATEMENTS

7.1 SII STANDARD LIMITED WARRANTY

7 1 1 Distributors and their authorized distribution have the responsibility of calling to the attention of their customers the following Snyder Industries, Inc. standard limited warranty, prior to acceptance of an order from the customer for any Snyder Industries, Inc. product. Record all required warranty information in section 7.4 and retain this information for use in the advent of a warranty question.

7 1 2 Snyder Industries, Inc warrants to the purchaser for use that if any manufactured tank product is proven to be defective in material or workmanship within 3 YEARS from the date of original invoice from factory, and Snyder Industries, Inc. is notified within 15 days after such defect is discovered, Snyder Industries, Inc. will (at company option) either replace or repair said part. Snyder Industries, Inc. warrants to the purchaser for use that if any tank fitting, attachment, or accessory product is proven to be defective in material or workmanship within 1 YEAR from the date of original invoice from factory, and Snyder Industries, Inc. is notified within 15 days after such defect is discovered, Snyder Industries, Inc. will (at company option) either replace or repair said part. This Snyder Industries Standard Limited Warranty does not apply to damage resulting from misuse, improper application of recommended materials, neglect, material wear, accident, or improper installation or maintenance. Said part will not be considered defective if it substantially fulfills performance specifications. THE FOREGOING STANDARD LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES OF MERCHANTABILITY, FITNESS FOR PURPOSE AND OF ANY OTHER TYPE, WHETHER EXPRESSED OR IMPLIED. Snyder Industries, Inc. neither assumes nor authorizes anyone to assume for it any other obligation or liability in connection with said tank product and will not be liable for incidental or inconsequential damages THE REMEDIES STATED HEREIN SHALL BE THE EXCLUSIVE REMEDIES AVAILABLE UNDER THIS STANDARD WARRANTY. CLAIMS UNDER THIS STANDARD LIMITED WARRANTY SHALL BE HANDLED UNDER THE SNYDER INDUSTRIES, INC. SERVICE POLICY Snyder Industries, Inc will not be responsible for any charges incurred in repairing or servicing any Snyder Industries, Inc. product except as such repairs are made

at Snyder Industries, Inc. or by Snyder Industries, Inc. personnel or as approved in writing from Snyder Industries, Inc. Customer Service.

7.2 **SII WARRANTY EXCEPTIONS**

7.2.1 Distributors and their authorized distribution have the responsibility of calling to the attention of their customers any exceptions to the Snyder Industries, Inc. standard limited warranty, prior to acceptance of an order from the customer for any Snyder Industries, Inc. product.

7.2.2 Due to the uniqueness of tank applications, Snyder Industries, Inc. may offer warranties other than the standard warranty. These warranty statements will be in writing from Snyder Industries, Inc. The warranty period may be longer than 3 years as in the case for purchased extended warranties, or the warranty period may be shorter than 3 years as in the case for certain chemical/material applications. Please consult Snyder Industries, Inc. if you have any questions regarding warranty coverage and/or requirements.

7.3 RETURN MERCHANDISE/WARRANTY CLAIM PROCEDURE

7.3.1 SII has specific procedures for return merchandise and warranty claims. To make a claim, please contact the Customer Service Department at SII by mail or by phone:

Snyder Industries, Inc
P.O BOX 4583
Lincoln, NE 68504
(402) 467-5221
FAX (402) 467-6493

The following information will be required to assist in filing your claim:

1 Product identification (tank size, part number, serial number, etc.)
2. SII customer order number
3. Name and phone number of person making the claim
4 Distributor/company name, address, and phone number
5 Description of reason for claim

7.4 **WARRANTY INFORMATION**

7.4.1 Record all required warranty information detailed below. Fax or mail this information to Snyder Industries at the number or address shown above. Retain a copy of this information for use in the advent of a warranty question.

7.4.2 Tank Part Number:

7.4.3 Tank Serial Number:

7.4.4 Tank Description/Size:

7.4.5 Date of Original Factory Invoice:

7.4.6 Snyder Customer Order Number:

7.4.7 Distributor Supplying Tank (name, address, and phone number):

7.4.8 Date of Water Pre-Test:

7.4.9 Water Pre-Test Observations:

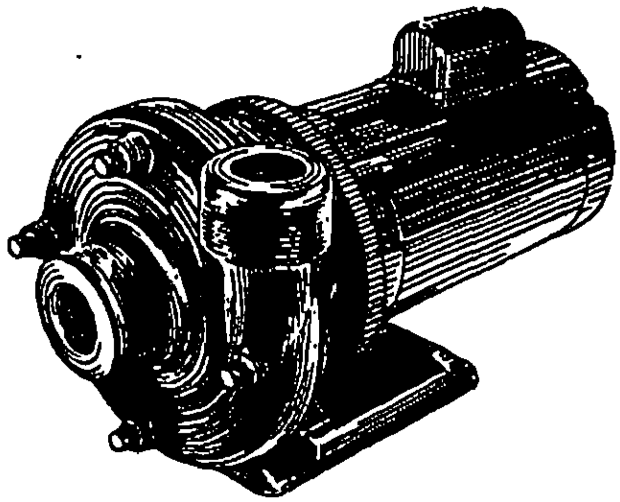
7.4.10 Type of Chemical Stored:

7.4.11 Concentration of Chemical:

7.4.12 Tank Use Temperature:

Installation and Operating Instructions

Grundfos Series E



Your Grundfos Series E End Suction pump is of the utmost quality. Combined with proper installation, your Grundfos pump will give you many years of reliable service.

To ensure the proper installation of the pump, carefully read the complete manual before attempting to install the pump.

SECTION 1.

Shipment Inspection

Examine your pump carefully to make sure that no damage has occurred during shipment.

Your Grundfos Series E pump should remain in its shipping carton until it is ready to be installed. This carton has been specially designed to protect the pump from damage. During unpacking and prior to installation, care should be taken to ensure the pump is not dropped or mishandled. Immediately report any damage in writing to the transportation company and ask to have it inspected. Do not destroy packing materials until the shipment is inspected and the claim is settled.

The position of the coupling (that connects the pump shaft to the motor shaft) is set at factory specifications. No adjustment is necessary or advised. Refer to *"Motor Replacement"* in Section 6, *"Operation and Maintenance"*, for proper coupling positioning procedures.

SECTION 2.

Applications and Operating Ranges

Before installing the pump, the following checks should be made to ensure that the proper operating conditions for the pump are present.

Applications

The Series E end suction pump is a general service pump designed to pump fluids in a wide range of applications.

Acceptable fluids include:

- Hot and cold water
- Clean, thin, non-aggressive and non-explosive fluids
- Consult manufacturer for fluids containing chlorine or hydrocarbons

Operating Ranges

- Maximum fluid temperature: 212°F
- Maximum working pressure: 125 PSIG
- Maximum ambient temperature: 104°F (40°C)

Consult manufacturer for higher ambient temperature conditions.

Installation

Pump Locati n

The pump should be located in a dry, well ventilated area which is not subject to freezing or extreme variations in temperature. Care must be taken to ensure that the pump is mounted at least 6 inches (150mm) from any obstruction or hot surfaces. The motor requires an adequate air supply to prevent overheating and should not be totally enclosed.

For open systems requiring suction lift, the pump should be located as close to the water source as possible to reduce piping losses.

Foundation

A secure, stable mounting base should be provided for the pump in order to minimize noise and vibration in the system. It is not recommended to hang the pump unit in the system piping without added support. Bolt hole center line dimensions for the various pump types are given in Figure 1.

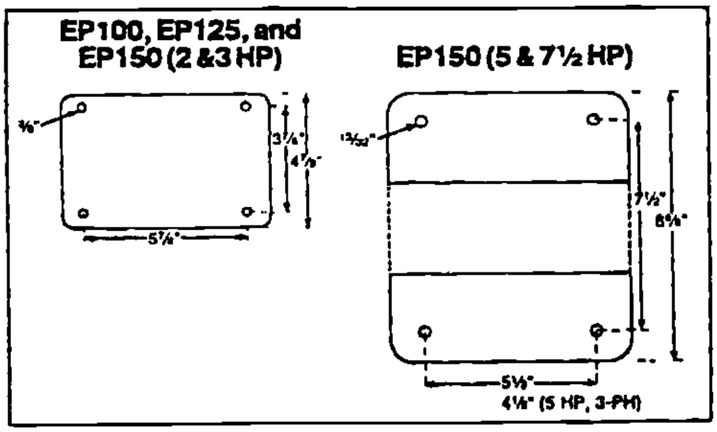


FIGURE 1: Bolt hole centers

Pipework

The use of pipe compound or Teflon® tape on all male threads is acceptable as a means of providing a positive seal at the pump port connections. Avoid using unnecessary fittings, valves or accessory items, especially in the vicinity of the pump suction and discharge ports. The piping should be adequately supported to reduce thermal and mechanical stresses on the pump.

Good installation practice recommends the system be thoroughly cleaned and flushed of all foreign materials and sediment prior to pump installation. If possible, the pump should not be installed at the lowest point in the system due to the natural accumulation of dirt and sediment. If there is excessive sediment or suspended particles present, it is advised a strainer or filter be used to prevent its entry into the pump.

Suction Pipe

The suction pipe should be adequately sized and run as straight and short as possible to keep friction losses to a minimum. This would generally dictate that the suction piping, fittings, valves and accessories be at least as large as the suction port connection of the pump. These should be larger if the distance to the water source is great.

Care should be taken to provide a means of pump isolation (e.g., gate or butterfly valves) in applications where the pump is in a pressurized or flooded suction condition.

If the pump is installed in a suction lift application, horizontal suction piping must rise gradually from the source to the pump and contain no high spots which allow air pockets to form.

Discharge Piping

It is suggested that a check valve and isolation valve be installed in the discharge pipe. Pipe, valves, and fittings should be at least the same diameter as the discharge pipe or sized in accordance with good piping practices to reduce fluid velocities and pipe friction losses. Pipe, valves and fittings must have a pressure rating equal to or greater than the maximum system pressure. Before the pump is installed, it is recommended that the discharge piping be pressure checked to at least the maximum pressure the pump is capable of generating or as required by codes or local regulations.

The standard discharge position for Grundfos Series E pumps is vertical (upward). To simplify pumping connections, however, the pump housing may be rotated to optional positions. The EP100, EP125, and EP150 (2 HP and 3 HP) models may be rotated to any of four positions while the EP150 (5 HP and 7½ HP) may be rotated to any of six positions. (See Figure 2)

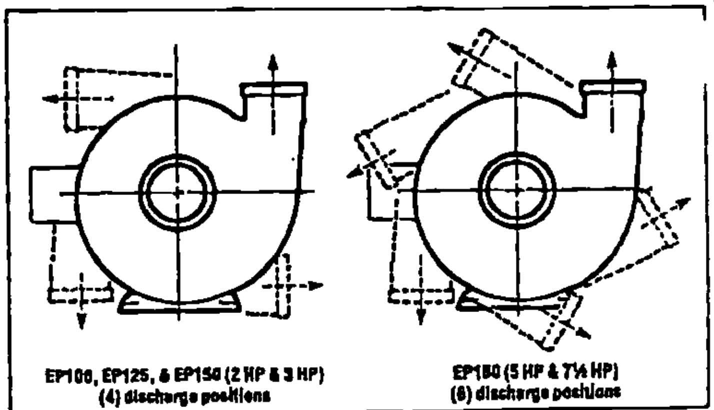


FIGURE 2: Piping connection positions (viewed from suction end)

Reposition the pump housing as follows:

1. Loosen and remove each of the cap screws that attach the pump housing to the motor adaptor.
2. Carefully lift the pump housing off of the motor adaptor and rotate it to the required position. Check that the o-ring is properly seated.
3. Apply Teflon® sealant to the cap screw threads.
4. Reinstall the cap screws and tighten diagonally and evenly.

Bypass

A bypass or pressure relief valve should be installed in the discharge pipe if there is any possibility that the pump may operate against a closed valve in the discharge line. Flow through the pump is required to ensure that adequate cooling and lubrication of the pump is maintained. See Table A for minimum flow rates.

TABLE A: Minimum Pumping Rates

PUMP TYPE	MINIMUM FLOW RATES
EP 100 (all)	3 U.S. GPM
EP 125 (all)	4 U.S. GPM
EP 150 2020	8 U.S. GPM
EP 150 3030	10 U.S. GPM
EP 150 5050	12 U.S. GPM
EP 150 7575	13 U.S. GPM

SECTION **4.**

Electrical

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electric Code and local codes and regulations.

WARNING

The safe operation of this pump requires that it be grounded in accordance with the National Electric Code and local governing codes or regulations. Connect the ground wire to the grounding screw in the terminal compartment and then to the **acceptable** grounding point.

M t r

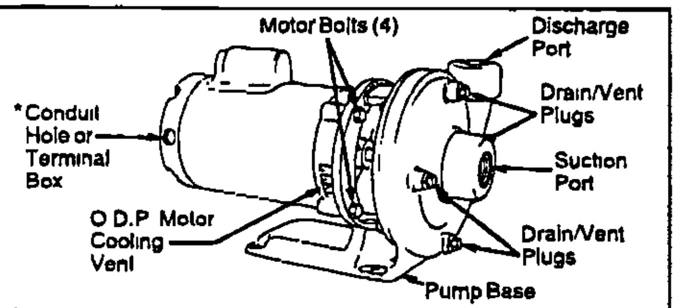
Grundfos Series E pumps are supplied with 3450 RPM. O.D.P., NEMA C frame motors which have jet pump service factors. T.E.F.C. motors (with minimum 1.15 service factors) are also available. Motors have been selected to operate without exceeding their service factor ratings. Motors for other voltages and frequencies are available on a special order basis. If you are replacing the pumping unit, but using a motor supplied separately, be sure to read the "Motor Replacement" instructions in Section 6, "Operation and Maintenance" for proper adjustment of the pump shaft.

Mot r Mounting Position

The motor can be mounted in any of four positions in 90° steps. To rotate the motor:

1. Remove the four bolts securing the motor to the pump.
2. Turn the motor to the desired position.
3. Replace the motor and securely tighten the four bolts.

NOTE: O.D.P. motors through 2 HP are supplied with cooling vents. These motors should remain mounted with the cooling vents positioned downward, especially where there is the possibility that liquid might splash onto the pump from above (i.e., rain).



*Standard motor position is the 9 o'clock position as shown. ½-2 HP O.D.P motors include a conduit hole. All other motors include a terminal box

FIGURE 3: Motor mounting positions

Supply Power

Verification of the electrical supply should be made to be certain the voltage, phase, and frequency match that of the pump motor. The proper operating voltage and other electrical information can be found on the motor nameplate. These motors are designed to run on ±10% of the nameplate rated voltage (+10% / −5% for 208 volt services).

For dual voltage motors, the motor should be internally connected to operate on the voltage closest to the 10% rating (i.e., a 208 volt motor should be wired per the 230 volt connection diagram). Wiring connection diagrams can be found on the plates attached to the motor.

WARNING: If voltage variations are larger than ±10%, DO NOT operate the pump.

Field Wiring

Wire sizes should be based on the current carrying properties of a conductor as recommended by the latest edition of the National Electric Code or local regulations.

Direct on line (D.O.L.) starting is approved due to the extremely fast run-up time of the motor and the low moment of inertia of the pump and motor. If D.O.L. starting is not acceptable and reduced starting current is required, an auto transformer or resistant starter should be used.

It is recommended that a fused disconnect be used for each pump where service and standby pumps are installed.

Motor Protection

SINGLE-PHASE MOTORS

Single phase Series E pumps are equipped with multi-voltage, squirrel cage induction motors with built-in thermal protection.

THREE-PHASE MOTORS

Series E pumps with three-phase motors must be used with the proper size and type of motor starter to ensure the motor is protected against damage from low voltage, phase failure, current imbalance, and overloads. A properly sized starter with manual reset and ambient-compensated extra quick trip in all three legs should be used.

The overload should be sized and adjusted to the current rating of the motor. ***Under no circumstances should the overloads be set to a higher value than the service factor current shown on the motor nameplate. This will void the warranty.***

Overloads for auto transformers and resistant starters should be sized in accordance with the recommendations of the manufacturer.

SECTION 5.

Pump Start-up

Priming the Pump and V nting the System

After the pump has been installed, wired and the system filled, the following procedures should be performed. CAUTION: Do not start the pump before priming and venting the pump. Never operate the pump dry.

To prime the pump in a closed system or an open system where the water source is above the pump, close the pump isolation valve(s) and remove the topmost drain/vent plug from the front of the pump volute. Gradually open the isolation valve in the suction line until a steady stream of airless water runs out of the open plug. Replace the plug and securely tighten. Completely open the isolation valves.

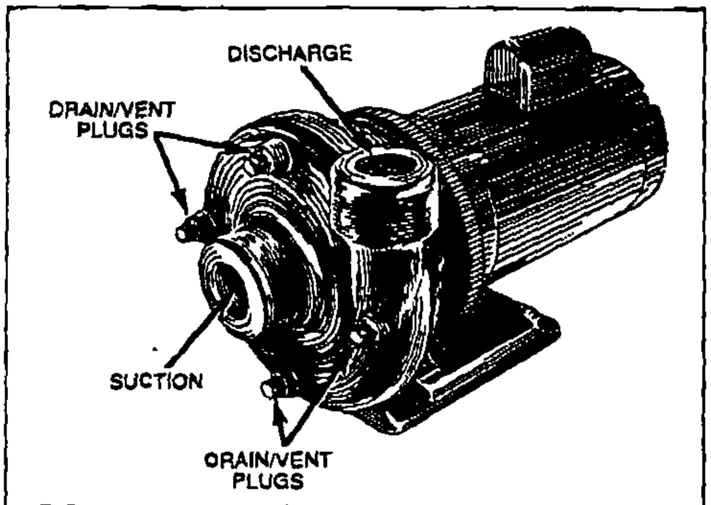


FIGURE 4: Priming the pump and venting the system

In open systems where the water level is below the pump inlet, the suction pipe and pump must be filled and vented of all air before starting the pump. This is best accomplished through the discharge port or an opening in the discharge piping at a level above the pump volute. Remove the topmost drain/vent plug. Pour water into the discharge until the suction piping and pump are completely filled. If the suction piping does not slope downward from the pump toward the water level, the air in the line must be purged while the system is being filled. Replace the drain/vent plug and securely tighten. Connect and/or seal the discharge piping.

Ch ck Motor Rotation

1. Switch power off.
2. Check to make sure the pump has been filled and vented.
3. Rotate the pump shaft to be certain it turns freely.
4. Verify that the electrical connections are in accordance with the wiring diagram on the motor.
5. Briefly switch the power on and observe the direction of rotation. ***When viewed from the motor end, the pump should rotate CLOCKWISE.*** (NOTE: Direction of rotation on Series pumps is opposite that of Series C, L, and 7000 7000 units.)
6. To reverse the direction of rotation, first switch off the supply power.
7. On three-phase motors, interchange any two power leads on the load side of the starter. On single-phase motors, see the connection diagram on the motor and change the wiring as required.
8. Repeat step 3 to ensure that improper rotation has not unthreaded the impeller from the pump shaft.
9. Switch on the power and again check the motor for proper rotation.

Starting and Adjusting

Before starting the pump, be sure to check:

1. Pump is primed.
2. Direction of rotation is COUNTERCLOCKWISE when viewed from the suction port.
3. All piping connections are tight and pipes are adequately supported.
4. Suction line isolation valve is completely open (if valve is installed).
5. For initial starting, the isolation valve in the discharge pipe should be closed and gradually opened after the pump is turned on. Opening this valve too fast may cause water hammering in the discharge pipe. Unless the discharge valve is being used as a flow throttling device, make sure the valve is completely open.
6. Check and record the voltage and amperage of the motor. Adjust the motor overloads if required.
7. Check and record operating pressures, if pressure gauges have been installed.
8. Check all controls for proper operation. If the pump is controlled by a pressure switch, check and adjust the cut-in and cut-out pressures. If low-water-level controls are used, be sure the low-water-level switch is properly adjusted so the pump cannot run if the pump should break suction.

Op ration and Maint nanc

Op rati n

When Grundfos Series E centrifugal pumps are installed in accordance with these instructions and sized for correct performance, they will operate efficiently and provide years of service. The pumps are water lubricated and do not require any external lubrication or inspection. The motors will require periodic lubrication as noted in the following maintenance information.

Under no circumstances should the pump be operated for any prolonged periods of time without flow through the pump. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed to allow sufficient water to circulate through the pump to provide adequate cooling and lubrication of the pump bearings and seals.

Pump cycling should be checked to ensure the pump is not starting more than 20 times per hour on ½ HP to 5 HP models or 15 times per hour on 7½ HP models. Rapid cycling is a major cause of premature motor failure due to increased heat build-up in the motor. If necessary, adjust controls to reduce the frequency of starts and stops.

FREEZE PROTECTION

If the pump is installed in an area where freezing could occur, the pump and system should be drained during freezing temperatures to avoid damage. To drain the pump, close the isolation valves and remove the drain/vent plugs at both the top and bottom of the pump volute. DO NOT replace the plugs until the pump is to be used again.

Maint nance

MOTOR LUBRICATION

Electric motors are pre-lubricated at the factory and do not require additional lubrication at start-up. Motors containing sealed bearings do not require additional lubrication during the first 15,000 hours of operation. Motors with grease fittings should ONLY be lubricated with a lithium-based grease.

TABLE B: Recommended lubrication

TYPE OF SERVICE	FREQUENCY OF GREASING
Seasonal (Motor is idle for more than 6 months)	Yearly
Intermittent	Semi-annually
Continuous	Quarterly

Approved Types of Greases

Shell Dolium R, FSSO Beacon 3, BP-XRB2, Shell Alvania 3, Mobil Grease 2, Texaco Regal, and Starfos Premium

DO NOT over grease the bearings. Over greasing will cause increased bearing heat and can result in bearing and/or motor failure.

At regular intervals, depending on the conditions and time of operation, the following checks should be made:

1. Pump meets required performance and is operating smoothly and quietly.
2. There are no leaks, particularly at the shaft seal.
3. The motor is not overheating.
4. Remove and clean all strainers or filters in the system.
5. Verify the tripping of the motor overload protection.
6. Check the operation of all controls. Check unit control cycling twice and adjust if necessary.
7. If the pump is not operated for unusually long periods, the unit should be maintained in accordance with these instructions. In addition, if the pump is not drained, the pump shaft should be manually rotated or run for short periods of time at monthly intervals.

If the pump fails to operate or there is a loss of performance, refer to Section 7, "Troubleshooting".

Motor Replacement

If the motor is damaged as a result of bearing failure, burning, or electrical failure, the following instructions detail how to remove the motor for replacement. It must be emphasized that motors used on Series E pumps are specifically selected to our rigid specifications. ***Replacement motors must be of the same NEMA C frame size and have the same service factor.*** Failure to follow these recommendations may result in premature motor failure.

DISASSEMBLY

1. Using the proper allen wrench, loosen the cap screw(s) in the coupling.
2. With the correct size wrench, loosen and remove the four bolts which hold the motor to the discharge section of the pump end motor support.
3. Move the motor straight back until the shaft is free from the coupling.

ASSEMBLY

1. Thoroughly clean the surfaces of the motor and pump end mounting flanges.
2. Set the motor on the pump end.
3. Place the terminal box in the desired position by rotating the motor. (NOTE: Refer to "Motor Mounting Positions" in Section 4, "Electrical", for the recommended mounting position for ⅓ HP through 2 HP O.D.P. motors.)
4. Insert the mounting bolts, then tighten diagonally and evenly.
5. Using a large screwdriver, raise the pump shaft by placing the tip of the screwdriver under the coupling collar of the pump shaft. Then, carefully move the shaft toward the motor until the impeller contacts the motor support and will move no further.
6. Now insert the appropriate spacing tool (see below) between the motor support and shaft coupling collar and allow the pump shaft to move back into the pump end until the collar bottoms on the spacing tool. Tighten the allen screw(s) in the motor keyway. This will position the impeller in the correct axial location. (See Figures 5A, B, & C)
7. Be certain the pump shaft can be rotated by hand. If the shaft cannot be rotated or it binds, repeat steps 5 and 6.

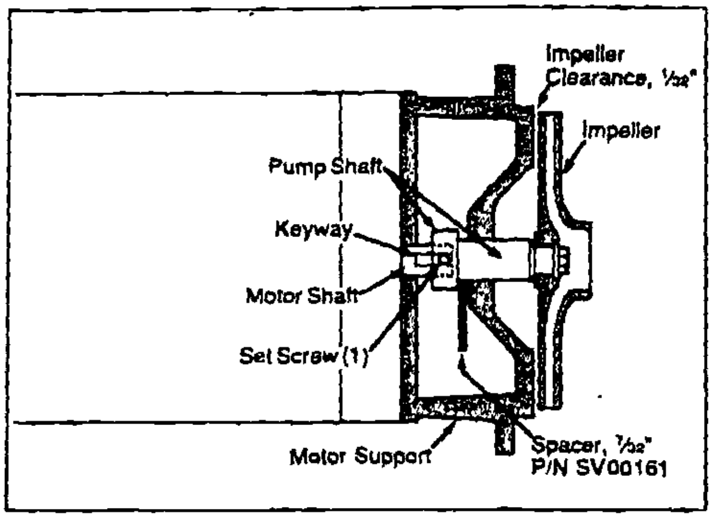


FIGURE 5A: Pump assembly (EP100 and EP125)

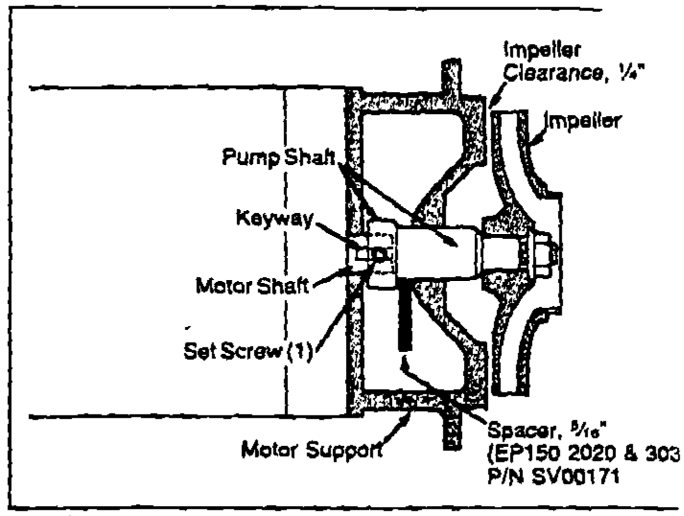


FIGURE 5B: Pump assembly (EP150 2020 & 3030)

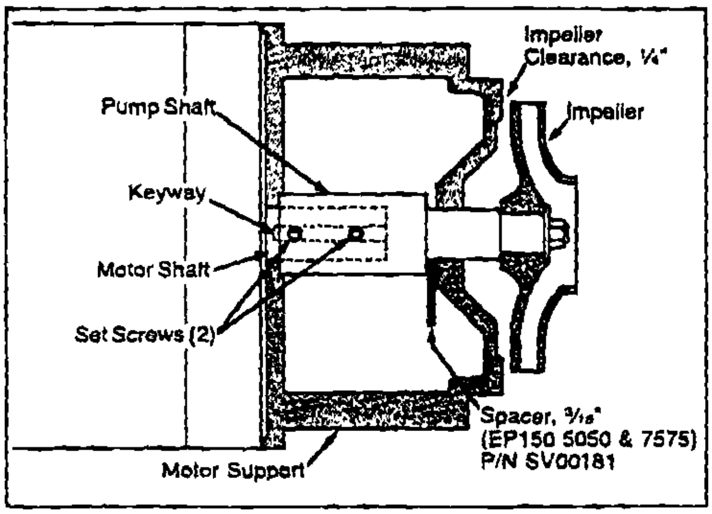


FIGURE 5C: Pump assembly (EP150 5050 & 7575)

TABLE C: Spacing Tool Selection

PUMP MODEL(S)	SPACING TOOL PART NO.	SPACING TOOL LENGTH	IMPELLER DISTA TO MOTOR SUPP
EP 100 (all)	SV 00 161	7/32" (5.6 mm)	1/32" (.80 mm
EP 125 (all)	SV 00 161	7/32" (5.6 mm)	1/32" (.80 mm
EP 150 (2020 & 3030)	SV 00 171	5/16" (7.9 mm)	1/4" (6.35 mn
EP 150 (5050 & 7575)	SV 00 181	3/16" (4.8 mm)	1/4" (6.35 mr

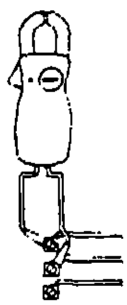
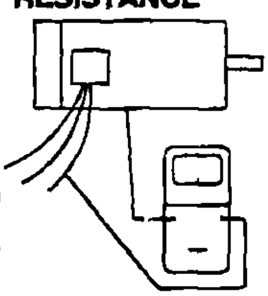
Troubl shooting

685 135

WHEN WORKING WITH ELECTRICAL CIRCUITS, USE CAUTION TO AVOID ELECTRICAL SHOCK. It is recommended that rubber gloves and boots be worn, and metal terminal boxes and motors be properly grounded before any work is done.

WARNING: Failure to ground the pump may result in serious electrical shock.

Pr liminary Tests

SUPPLY VOLTAGE 	**How to Measure** Use a volt meter (set to proper scale) to measure the voltage at the pump terminal box or starter. On single-phase units, measure between power leads L1 and L2 (or L1 and N for 115 volt units). On three-phase units, measure between: • Power leads L1 and L2 • Power leads L2 and L3 • Power leads L3 and L1	**What It Means** When the motor is under load, the voltage should be within ± 10% of the nameplate voltage. Larger voltage variation may cause winding damage. Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected. If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.
CURRENT MEASUREMENT 	**How to Measure** Use an ammeter (set on the proper scale) to measure the current on each power lead at the terminal box or starter. See the motor nameplate for amp draw information. Current should be measured when the pump is operating at constant discharge pressure.	**What It Means** If the amp draw exceeds the listed service factor amps (SFA) or if the current imbalance is greater than 5% between each leg on three-phase units, check the following: 1. Burned contacts on the motor starter. 2. Loose terminals in starter or terminal box or possible wire defect. 3. Too high or too low supply voltage. 4. Motor windings are shorted or grounded. Check winding and insulation resistances. 5. Pump is damaged causing a motor overload.
INSULATION RESISTANCE 	**How to Measure** Turn off power and disconnect the supply power leads in the pump terminal box. Using an ohm or mega ohm meter, set the scale selector to Rx 100K and zero adjust the meter. Measure and record the resistance between each of the terminals and ground.	**What It Means** Motors of all HP, voltage, phase and cycle duties have the same value of insulation resistance. Resistance values for new motors must exceed 1,000,000 ohms. If they do not, the motor should be repaired or replaced.

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
A. Pump Does Not Run 685 136	1. No power at motor.	Check for voltage at motor terminal box.	If no voltage at motor, check feeder panel for tripped circuits and reset circuit.
	2. Fuses are blown or circuit breakers are tripped.	Turn off power and remove fuses. Check for continuity with ohm meter	Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation, motor, and wires must be checked.
	3. Motor starter overloads are burned or have tripped out.	Check for voltage on line and load side of starter.	Replace burned heaters or reset. Inspect starter for other damage. If heater trips again, check the supply voltage and starter holding coil.
	4. Starter does not energize.	Energize control circuit and check for voltage at the holding coil.	If no voltage, check control circuit fuses. If voltage, check holding coil for shorts. Replace bad coil.
	5. Defective controls.	Check all safety and pressure switches for operation. Inspect contact in control devices.	Replace worn or defective parts or controls.
	6. Motor is defective.	Turn off power and disconnect wiring. Measure the lead to lead resistances with the ohm meter (RX-1). Measure lead to ground values with ohm meter (RX-100K). Record measured values.	If an open or grounded winding is found, remove the motor and repair or replace.
	7. Defective capacitor (single-phase motors)	Turn off power and discharge capacitor. Check with ohm meter (RX-100K).	When the meter is connected to the capacitor, the needle should jump towards "0" ohms and slowly drift back to infinity. Replace capacitor if defective.
	8. Pump is bound	Turn off power and manually rotate pump shaft.	If shaft does not rotate easily, check coupling setting and adjust as necessary. If shaft rotation is still tight, remove pump and inspect. Disassemble and repair.
B. Pump Runs But at Reduced Capacity or Does Not Deliver Water.	1. Wrong rotation.	Check wiring for proper connections.	Correct wiring.
	2. Pump is not primed or is airbound.	Turn pump off, close isolation valves(s), and remove the priming plug. Check fluid level.	Refill the pump, replace the plug, and start the pump. Long suction lines must be filled before starting the pump
	3. Strainer, check valve, or foot valve is clogged.	Remove strainer, screen or valve and inspect.	Clean and replace. Reprime the pump.
	4. Suction lift is too large.	Install compound pressure gauge at the suction side of the pump. Start pump and compare reading to performance data.	Reduce suction lift by lowering the pump, increasing the suction line size, or removing high friction loss devices.
	5. Suction and/or discharge piping leaks.	Pump runs backwards when turned off. Air in suction pipe.	Suction pipe, valves, and fittings must be airtight. Repair any leaks and retighten all loose fittings.
	6. Pump is worn.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shut-off	Convert PSI to feet (Measured PSI x 2.31 ft. / PSI = ____ ft.) Refer to the specific pump curve for shut-off head for that pump model. If head is close to curve, pump is probably OK. If not, remove pump and inspect.
	7. Pump impeller or connection port is clogged.	Disassemble and inspect pump passageways.	Remove any foreign materials found.

Troubl shooting Chart (cont.)

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
C. Pump Cycles Too Much	1. Pressure switch is not properly adjusted or is defective.	Check pressure setting on switch and operation. Check voltage across closed contacts.	Readjust switch or replace if defective.
	2. Level control is not properly set or is defective.	Check setting and operation.	Readjust setting (refer to level control manufacturer's data). Replace if defective.
	3. Insufficient air charging or leaking tank or piping.	Pump air into tank or diaphragm chamber. Check diaphragm for leak. Check tank and piping for leaks with soap and water solution. Check air to water volume.	Repair as necessary.
	4. Tank is too small	Check tank size and air volume in tank. Tank volume should be approximately 10 gallons for each gpm of pump capacity. The normal air volume is ⅔ of the total tank volume at the pump cut-in pressure.	Replace tank with one of correct size.
	5. Pump is oversized.	Install pressure gauges on or near pump suction and discharge ports. Start and run pump under normal conditions, record gauge readings.	Convert PSI to feet (Measured PSI x 2.31 ft. / PSI = _____ ft.) Refer to the specific pump curve for that model. Ensure that total head is sufficient to limit pump delivery within its design flow range. Throttle pump discharge flow if necessary.
D. Fuses Blow or Circuit Breakers or Heaters Trip	1. Low voltage.	Check voltage at starter panel and motor.	If voltage varies more than ± 10%, contact power company. Check wire sizing.
	2. Starter overloads are set too low.	Cycle pump and measure amperage.	Increase heater size or adjust trip setting to a maximum of motor nameplate (full load) current.
	3. Three phase current is imbalanced.	Check current draw on each lead to the motor.	Must be within ± 5%. If not, check motor and wiring. Rotating all leads may eliminate this problem.
	4. Motor is shorted or grounded.	Turn off power and disconnect wiring. Measure the lead-to-lead resistance with an ohm meter (RX-1). Measure lead-to-ground values with an ohm meter (RX-100K) or a megaohm meter. Record values.	If an open or grounded winding is found, remove the motor, repair and/or replace.
	5. Wiring or connections are faulty.	Check proper wiring and loose terminals.	Tighten loose terminals. Replace damaged wire.
	6. Pump is bound.	Turn off power and manually rotate pump shaft.	If shaft does not rotate easily, check coupling setting and adjust as necessary. If shaft rotation is still tight, remove pump and inspect. Disassemble and repair.
	7. Defective capacitor (single-phase motors).	Turn off the power and discharge the capacitor. Check with ohm meter (RX-100K).	When the meter is connected to the capacitor, the needle should jump toward "0" ohms and slowly drift back to infinity. Replace it defective.
	8. Motor overloads at higher ambient temperature than motor.	Use a thermometer to check the ambient temperature near the overloads and motor. Record these values	If ambient temperature at motor is lower than at the overloads, especially where temperature at overloads is above 104°F (40°C), ambient compensated heaters should replace standard heaters.

685 138

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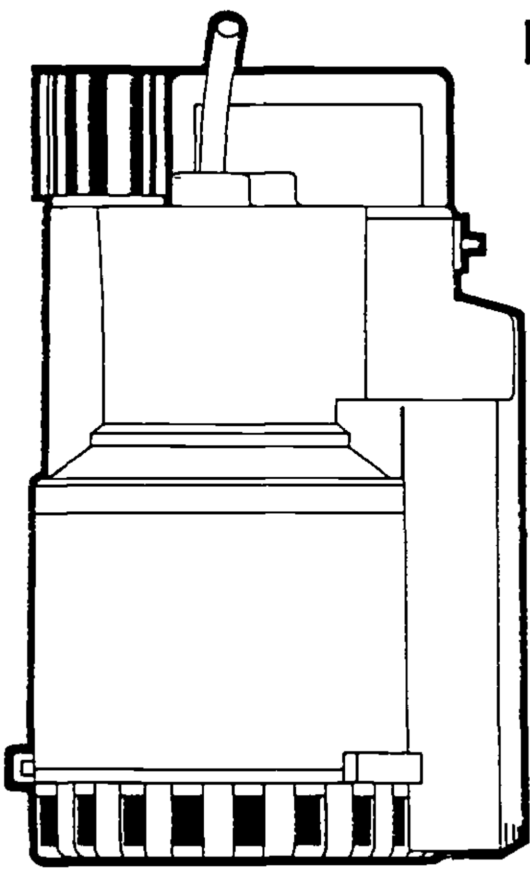
Installation and Operating Instructions

ABS

Drainage Pumps – Robusta 300WTS
Robusta 200WTS
Robusta 120WTS



- **BUILT-IN CHECK VALVE**

- LIGHT WEIGHT
- ENERGY EFFICIENT
- AUTOMATIC OR MANUAL
- BUILT-IN THERMAL PROTECTION
- WATER COOLED

Distributed By:

ABS PUMPS INC, 140 Pond View Drive, Meriden CT 06450 — 7156. (203) 238 - 2700
Fax: (203) 238 - 0738

685 139

APPLICATION

Compact submersible drainage pumps from ABS are used where large quantities of clear, rain or dirty water must be pumped quickly and reliability.

Permanent installations of pumps include basement and industrial sumps for water removal. They are also suitable for pumping washing effluent for the drainage of buildings and pumping rainwater out of lower level rooms or underpasses.

They are used as portable pumps to fill or empty containers of every type, for use in drainage pits, to maintain dry conditions in ditches and to pump out flooded cellars

HANDLING

The pump is easy to transport and should always be carried by the carrying handle. It should never be suspended or raised by means of the power cable.

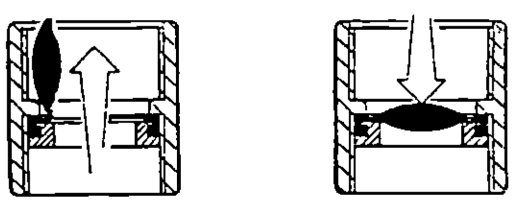
INSTALLATION AND OPERATION

The pumps are supplied ready for operation.

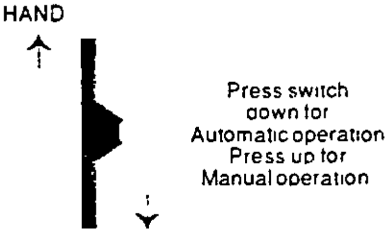
WARNING: Pumps must be installed in accordance with governing national and local electrical codes

NOTE: PUMP DISCHARGE CONTAINS AN INTERNAL BUILT-IN CHECK VALVE *–see illustration*

BUILT-IN CHECK VALVE



SWITCH



FOR AUTOMATIC OPERATION of pumps, install discharge hose or pipe to pump discharge. Position the pump in the sump, switch to the automatic position by pushing the switch down, and energize with the correct voltage The float switch will now start the pump when the water level reaches about 6"; pump shuts off at about 2". Be sure to test automatic operation after installing to make sure pump is operating properly

FOR MANUAL OPERATION, install discharge hose or pipe to pump discharge, place the pump in the water to be pumped. switch to the manual "Hand" position by pushing the switch up and energize with the correct voltage. Switch the pump off when the water level reaches approximately 2", by pushing the switch down into the automatic position, or by unplugging the power cord.

NOTE: In portable applications, when a sump is pumped down below 1" of water, the pump may require approximately 30 seconds to purge air from the discharge when restarting

MAINTENANCE

The pump has permanently lubricated bearing and an overload protection device to ensure maximum pump serviceability. Regular inspection and maintenance are, however, recommended in order to ensure long service life.

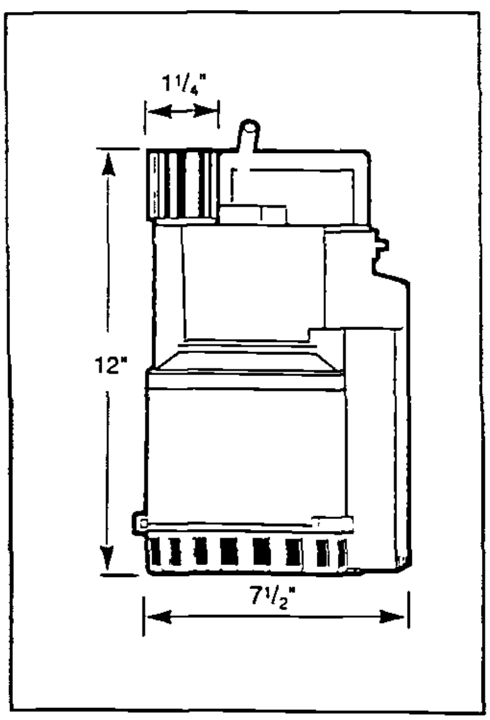
Always disconnect pump from electrical source before performing any type of maintenance The pump (and float area) should be cleaned from time-to-time (depending on degree of dirt present), and the float cover and inlet screen cleaned and rinsed in clean water. The float cover is removed first and then the inlet screen can be removed by turning it clockwise. This also allows the removal of the lower volute, so that the impeller area may also be cleaned.

To clean the float switch area, do so after removing the inlet screen and the volute. This now exposes a large portion of the bottom area of the float switch assembly. This area can now be rinsed easily with running water.

NOTE: When replacing the bottom volute, be sure the small hole toward the outside fits over the locating pin.
When replacing float cover, be sure that float is in correct position.

Never open the motor section of the pump, as dismantling could damage the seals

DIMENSIONS



TECHNICAL DATA:

MODEL	ROBUSTA 300WTS	ROBUSTA 200WTS	ROBUSTA 120WTS
Current	Single Phase	Single Phase	Single Phase
HP	1/2	1/3	1/4
RPM	3450	3450	3450
Voltage	115	115	115
Amps		See Pump Nameplate	
Discharge	1¼"	1¼"	1¼"
Height	12"	12"	12"
Width	7½"	7½"	7½"
Weight	13lbs	12 5lbs	11 5lbs
Cable	10 ft	10 ft , U L listed	10 ft , U L listed

685 141

WARNING

WARNING: Risk of electrical shock – this pump is supplied with a grounding conductor and grounding-type attachment plug To reduce the risk of electrical shock, be certain that it is connected only to a properly grounded, grounding type receptacle.

Warranty

ABS Pumps Inc. warrants its ROBUSTA Pumps to be free from defects in workmanship and material for a period of twelve (12) months from the date of sale to end customer. Pumps used in transportable (i.e. contractor dewatering) applications carry a six (6) month warranty from the date of sale to end customer This warranty does not cover the pumping of chemically or abrasively polluted water. ABS Pumps Inc. shall not be liable for any special, indirect or consequential damages of any kind. Defective equipment will be repaired or replaced. Returns must have prior written authorization from the company and be shipped prepaid.

NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WILL APPLY

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GEMS®

Instruction Bulletin No. 72547

Single-Station Level Switches

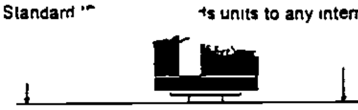
For additional technical information concerning Gems Single-Station Level Switches, consult our product catalog or contact Gems directly

Series	Mounting	HEX Size	Float Diameter
LS-1700**	1/8" NPT	1/2"	1" (1-13/32" - slosh shield version)
LS-1750**	1/8" NPT	1/2"	1-1/2" (1-13/16" - slosh shield version)
LS-1755**	1/8" NPT	1/2"	1-1/32"
LS-1800**	1/8" NPT	1/2"	1-1/4"
LS-1850**	1/2" NPT	—	3-1/2"
LS-1900**	1/4" NPT	5/8"	1-7/8"
LS-1900TFE*	1/4" NPT	21/32"	2-1/8"
LS-1950**	1/4" NPT	5/8"	2-1/16"
LS-19735*	1/4" NPT	5/8"	1-1/2"
LS-3*	1/8" NPT 3/8" - 16 Str Thd	1/2"	1"
<u>LS-3 Specials</u>			
P/N 142545*	1/8" NPT	1/2"	1-1/4"
P/N 76707*	1/8" NPT	1/2"	1-7/8"
LS-30*	1/4" NPT	5/8"	1-7/8"
LS-38760***	1/4" NPT	—	1-7/8"
<u>LS-77700</u>**			
Type I	1/8" NPT	1/2"	1"
Type II	3/8" - 24 Str Thd	3/4"	1-1/2"
LSP-54000*	"" NPT	1-3/8"	3"
TH800-A*** Level Temp	1/4" NPT	5/8"	1-1/4"

* Plastics ** Alloys ***Specialty Switches

Installation

A standard NPT female boss in tank top, bottom or side is all that is required Units operate in any attitude - from the vertical to a 30° inclination - with lead wires up or down Standard '" 'ts units to any intermediate level in the tank *(Figure 1)*



Moisture Protection When moisture exists in conduit a down the wire leads and into the switch assembly exists

685 143

Definition of Variables Used in Examples Below

A = Mounting Length

T = Thread Engagement

P = Distance from coupling (bung) top to inside surface of tank or bracket

L_0 = Overall length from bottom of mounting

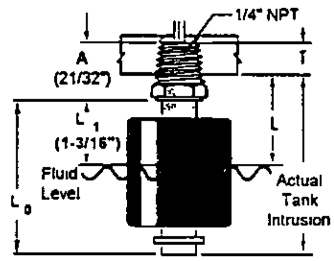
L = Switch actuation level as measured from inside surface of tank or bracket to fluid surface

L_1 = Switch actuation level, nominal, as measured from bottom of mounting (based on a liquid specific gravity of 1 0)

Internally Mounted
- Standard Length -

LS-1900 Series internally mounted through a 1/4" NPT hole To calculate "L" dimension

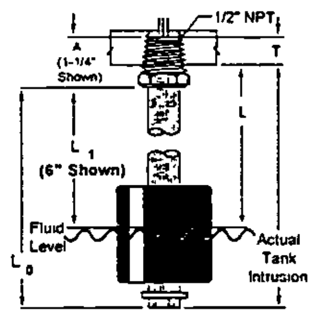
L = L_1 + (A-T)
L = 1-3/16" + (21/32" - 39")
L = 1 46"



Internally Mounted
- Configurable Length -

LS-800 Series (Type 1) internally mounted through a 1/2" NPT hole To calculate "L" dimension

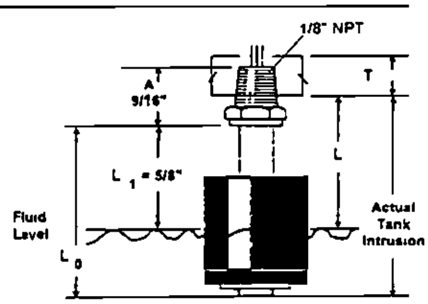
L = L_1 + (A-T)
L = 6" + (1-1/4" - 53")
L = 6 72"



Internally Mounted
- Standard Length -

LS-1700/1750 internally mounted through a 1/8" NPT hole To calculate "L" dimension

L = L_1 + (A-T)
L = 63" + (56" - 27")
L = 92"



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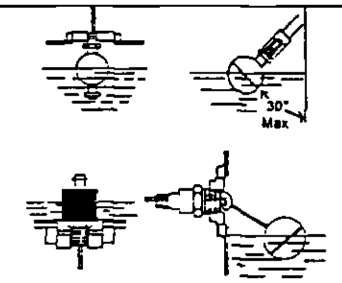
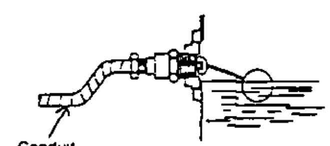
due to a high resistance path through the moisture The following suggestions may help to prevent this from happening

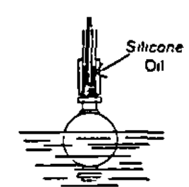
1 Pitch conduit away from the level switch when possible so that condensation will drip away from the level switch assembly *(Figure 2)*
2 When a vertical run of extension pipe is used to extend a level switch down from the top of the tank, a non-conductive silicone oil should be used to fill the vertical run Alternatively an appropriate potting may be used to fill the vertical run to occupy the space in which condensation will normally form *(Figure 3)*



- Figure 1 -



- Figure 2 -



- Figure 3 -

CAUTION

Most of GEMS level products incorporate a potting cap or are *fully potted Due to the bonding characteristics of the potting to* the wire leads there is no way of assuring a water-tight seal at the potting joint Our potting cap will resist moisture to some degree, but the precautions mentioned above should be used to assure moisture doesn't enter the switch and cause a short

Consult your GEMS representative for more suggestions on how to lessen the effects of moisture

Thread Treatment

1 Sealing

When threading metal threads into a metal coupling pipe sealant or Teflon® tape is recommended Due to potential compatibility problems, when sealing plastic threaded units a compatible pipe sealant such as No More Leaks™ from Permatex® is recommended

2 Tightening

When threading a plastic level switch into a metal coupling, the installer should use a suitable wrench and tighten the threads one to one and one-half additional turns past hand-tight Over-torquing of the threads will result in damage to the plastic mounting plug

3 The Effect of Thread Engagement on Actuation Points

The length of mounting threads engaged at installation is important in calculating switch actuation points and the actual length of stem extending into the tank Use the chart below to find the thread engagement length (T) for a given NPT size Factor the dimension into any calculation of switch actuation levels (L) and overall length (L_o)

	NPT							
	1/8"	1/4"	1/2"	3/4"	1"	1-1/4"	2"	3"
T Dim	27"	39"	53"	55"	68"	71"	76"	1 20"

- Examples on next page -

685-145

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GEMS®

Instruction Bulletin No. 72547

Single-Station Level Switches

For additional technical information concerning Gems Single-Station Level Switches, consult our product catalog or contact Gems directly

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LS-77700**			
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Installation

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Moisture Protection When moisture exis s in conduit a down the wire leads and into the switch assembly exists

SULFURIC ACID FEED SYSTEM

- Acid Storage Tank (Not Available)
- Acid Feed Pump
- Static Mixer (Not Available)
- pH Controller
- pH Transmitter
- pH PreAmp
- pH Sensor

685 147

ELECTRONIC METERING PUMPS

INSTALLATION
MAINTENANCE
TROUBLESHOOTING

Please record the following data:
(Information on Pump Box and Pump Data Plate)

Pump Model Number: ______________________
Pump Serial Number: ______________________
Installation Date: ______________________
Installation Location: ______________________

When ordering replacement parts for your LMI Metering Pump or accessory, please include the complete model number and serial number of your unit.

LMI
LIQUID METRONICS DIVISION
MILTON ROY
ISO9001 Certified • a unit of Sundstrand Corporation
8 Post Office Square • Acton, MA 01720 U.S.A.
TEL (508) 263-9800 • FAX (508) 264-9172

Printed in USA
Specifications - subject to change without notice.
Replaces same of Rev. J 8/96
1615.J 12/96

685 148

CONTENTS

685 149

1.0 INTRODUCTION

LMI is the world's most versatile manufacturer of economical and efficient metering pumps. This manual addresses the installation, maintenance and troubleshooting procedures for manually and externally controlled pumps. LMI has a worldwide network of stocking representatives and authorized repair centers to give you prompt and efficient service.

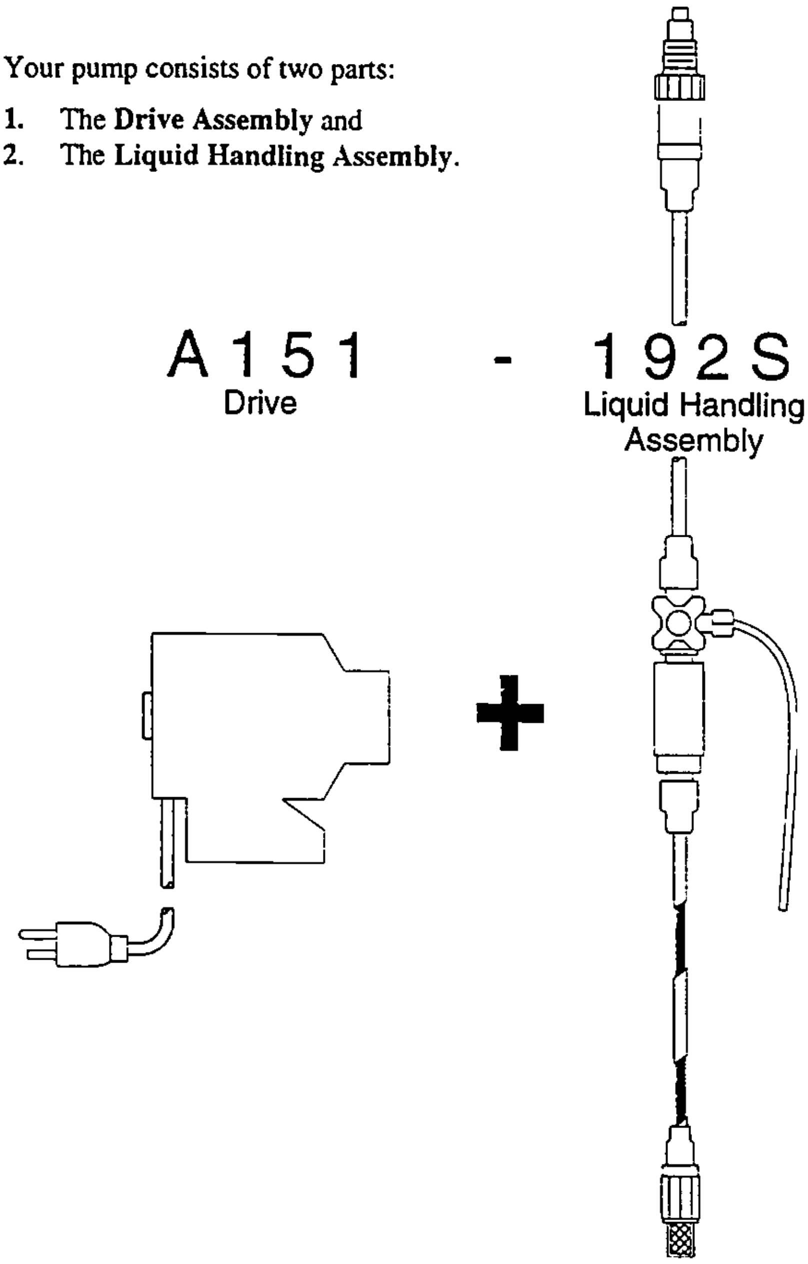
Please review this manual carefully. Pay particular attention to warnings and precautions. Always follow good safety procedures, including the use of proper clothing, eye and face protection.

This manual is for A, B, C, E, J, P Series pumps.

EXAMPLE:

Your pump consists of two parts:

1. The **Drive Assembly** and
2. The **Liquid Handling Assembly**.

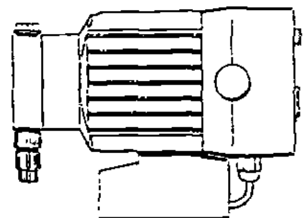


685 151

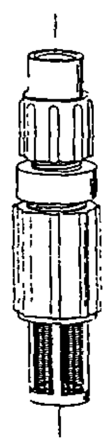
2.0 UNPACKING

Your carton will contain the following items. Please notify the carrier immediately if there are any signs of damage to the pump or its parts. Notify your pump supplier if any of the following parts are missing.

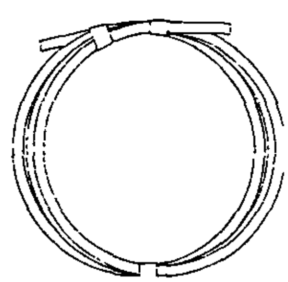
Please refer to the enclosed Drive Assembly Parts List Sheet for an illustration of your complete pump, electrical diagram and a parts list.



Metering Pump

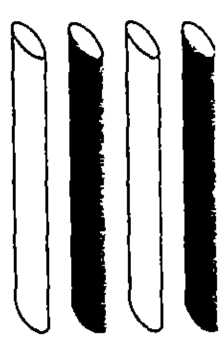


Foot Valve

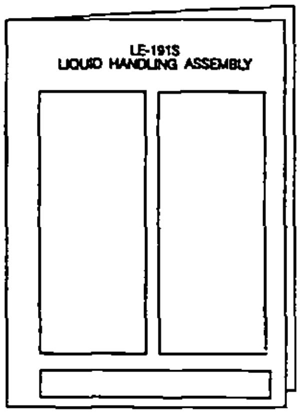


Tubing

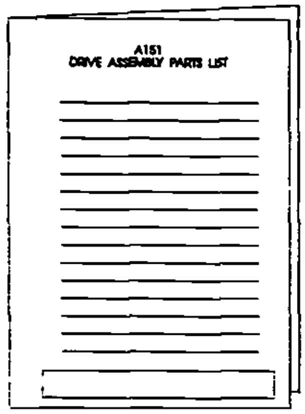
Depending on the model, your carton may contain 0, 1, 2 or 3 rolls of tubing Your carton may contain an additional roll of clear vinyl tubing, this is for connection to the SUCTION SIDE OF THE PUMP HEAD ONLY



Suction Tubing Straightener

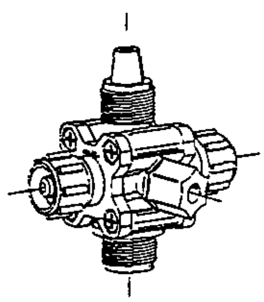


Liquid Handling Assembly Sheet



Drive Assembly Parts List & Exploded View Drawing

Injection Check Valve



FOUR FUNCTION Valve (4-FV) and Tubing

Your carton may or may not contain a 4-FV, an accessory for pump models ending in "M" or "S".

685 153

3.0 PRE-INSTALLATION INSTRUCTIONS

The following precautions should be taken when working with LMI metering pumps. Please read this section carefully prior to installation.

3.1 Precautions

Protective Clothing

ALWAYS wear protective clothing, face shield, safety glasses and gloves when working on or near your metering pump. Additional precautions should be taken depending on the solution being pumped. Refer to MSDS precautions from your solution supplier.

Water Pre-Prime

All LMI pumps are pre-primed with water when shipped from the factory. If your solution is not compatible with water, disassemble the Pump Head Assembly. Thoroughly dry the pump head, valves, seal rings, balls and Liquifram® (diaphragm). Re-assemble head assembly tightening screws in a crisscross pattern. Refill the pump head with the solution to be pumped before priming the pump. (This will aid in priming).

Solution Compatibility

Your Liquid Handling Assembly Sheet lists the materials of construction included in the liquid handling portion of your pump. Should you have any further compatibility questions on your LMI Metering Pump, review the **LMI Pump Selection Guide** and **Chemical Resistance Chart** for compatibility. If this sheet is not available to you, call your local LMI distributor, or the LMI Customer Service Department for further information.

Tubing Connections

Inlet and outlet tubing or pipe sizes must not be reduced. Make certain that all tubing is SECURELY ATTACHED to fittings prior to start-up. (See Section 4.3, Tubing Connections). ALWAYS use LMI supplied tubing with your pump, as the tubing is specifically designed for maximum compatibility with the pump operation. It is recommended that all tubing be shielded to prevent possible injury in case of rupture or accidental damage.

Fittings And Machine Threads

All fittings should be hand tightened to a maximum of 1/8 - 1/4 turn after the fitting contacts the seal ring. DO NOT OVERTIGHTEN FITTINGS. Overtightening or use of a pipe wrench can cause damage to the fittings, seal rings, or pump head, causing the pump to LOSE PRIME OR NOT FUNCTION.

All LMI pumps have straight 3/4"-16 or 1"-12 machine threads on the head and fittings and are sealed by the seal rings. DO NOT use Teflon tape or pipe dope to seal threads. Teflon Tape may only be used on the 1/2" NPT thread side of the Injection Check Valve before installing in a pipe line or tee.

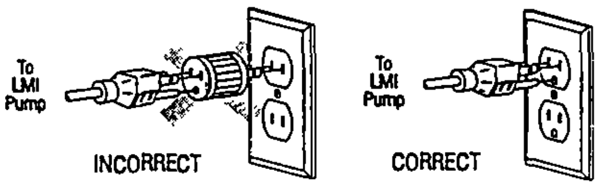
Plumbing

Always adhere to your local plumbing codes and requirements. Be sure installation does not constitute a cross connection. Check local plumbing codes for guidelines. LMI is not responsible for improper installations.

685 155

Electrical Connections

WARNING: to reduce the risk of electrical shock, the metering pump must be plugged into a grounded outlet with ratings conforming to the data on the pump control panel. The pump must be connected to a good ground. **DO NOT USE ADAPTERS!** All wiring must conform to local electrical codes.



4.0 INSTALLATION

4.1 Pump Location and Installation

Locate pump in an area convenient to solution tank and electrical supply.

The pump should be accessible for routine maintenance, and should not be subjected to ambient temperatures above 122°F (50°C). If the pump will be exposed to direct sunlight, LMI black, UV resistant tubing should be installed.

4.2 Pump Mounting

The pump can be mounted in one of two ways:

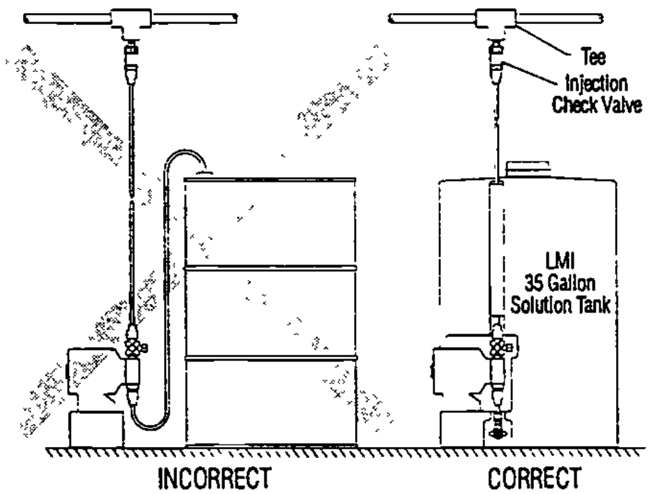
A. **FLOODED SUCTION** (ideal installation) or

B. **SUCTION LIFT** - when suction lift is less than 5 feet (1.5 m) for solutions having a specific gravity of water. For denser solutions, consult the factory.

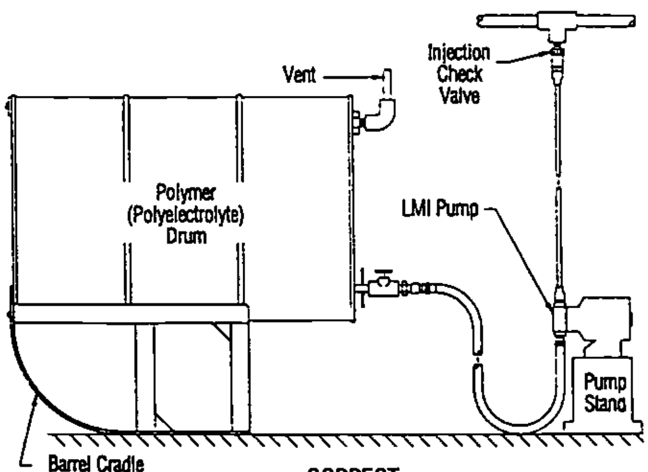
Your LMI metering pump must be mounted so that the suction and discharge valves are vertical. **NEVER position pump head and fittings horizontally.**

4.2A Flooded Suction

The pump is mounted at the base of the storage tank. This installation is the most trouble-free, and is recommended for very low outputs, solutions that gasify, and high viscosity solutions. Since the suction tubing is filled with solution, priming is accomplished quickly and the chance of losing prime is reduced.



Avoid this type of false flooded suction.



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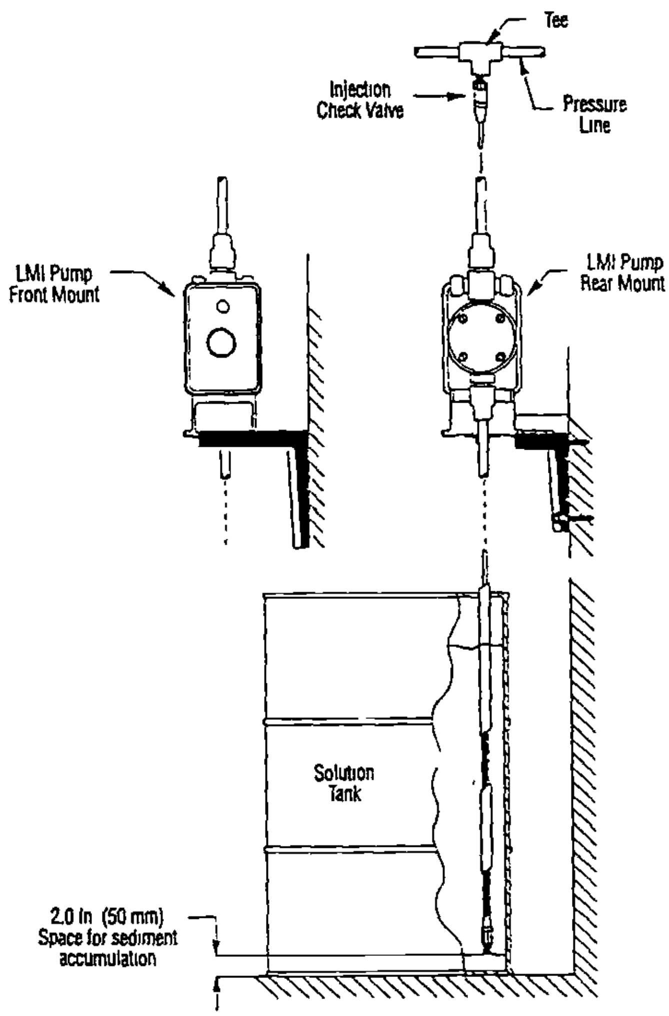
685 157

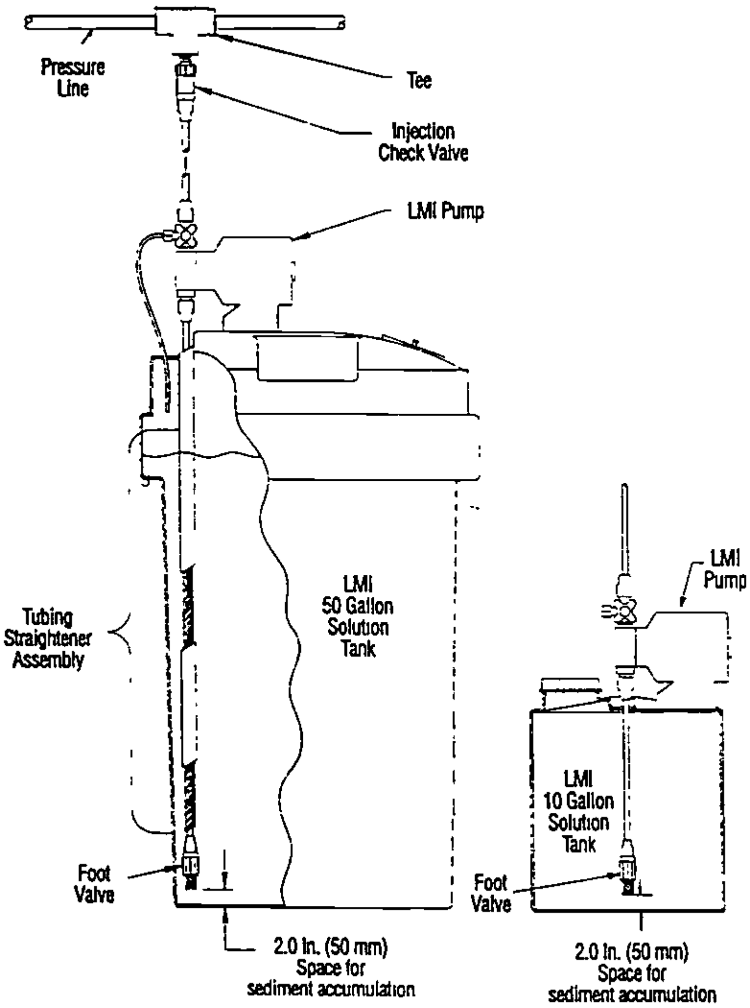
4.2B1 Suction Lift - Wall Bracket Mount

The pump may be mounted using an LMI Wall Mount Bracket Assembly (part no. 34643) directly above the solution tank. A pump mounted in this manner allows for easy changing of solution tanks or drums.



4.2B2 Suction Lift - Tank Mount

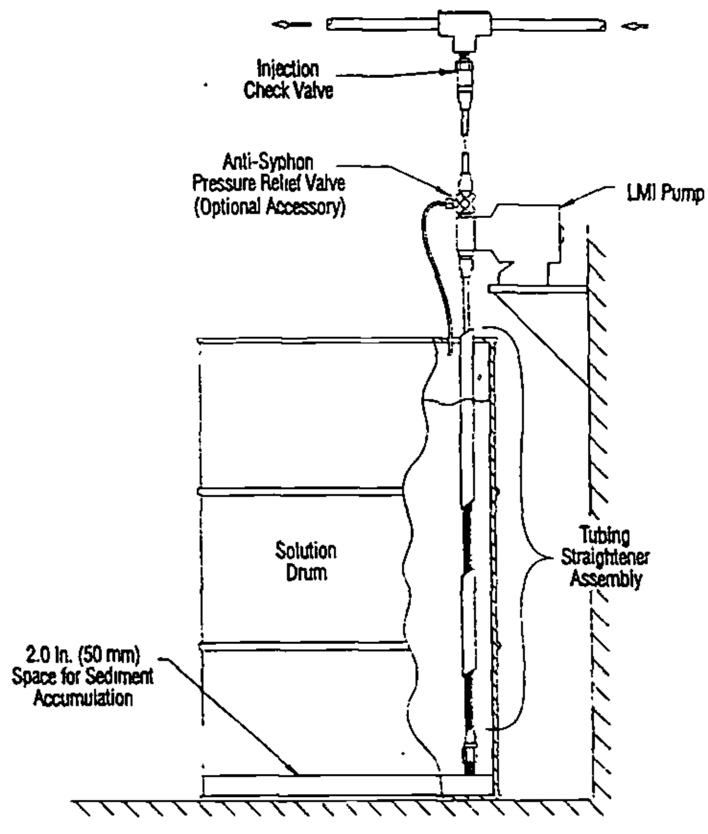
The pump may be mounted on a molded tank provided there is a recess to keep pump stationary. LMI 10 gallon tanks (part no. 27421) and 50 gallon tanks (part no. 26350) have molded recesses for pump mounting.



685 159

4.2B3 Suction - Shelf Mount

The pump may be mounted on a shelf (customer supplied) maintaining a suction lift of less than 5 feet (1.5 m). An LMI mounting kit (part number 10461) is available for securing the pump to a shelf.



4.3 Tubing Connections

A. Use only LMI tubing.

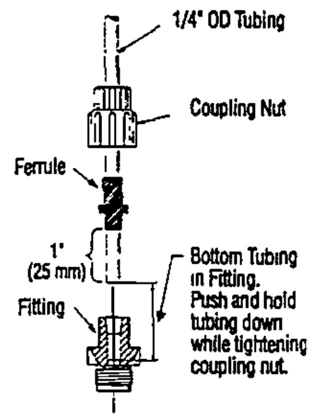
B. **DO NOT USE CLEAR VINYL TUBING ON THE DISCHARGE SIDE OF THE PUMP.** The pressure created by the pump can rupture the vinyl tubing.

C. Before installation, all tubing must be cut with a clean square end.

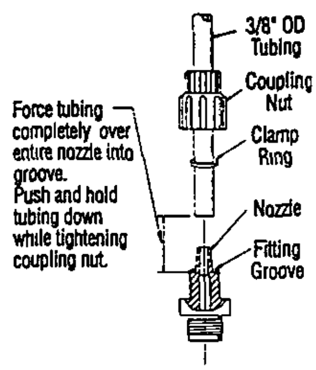
D. Valve and head connections from the factory are capped or plugged to retain pre-prime water. Remove and discard these caps or plugs before connecting tubing.

DO NOT USE PLIERS OR PIPE WRENCH ON COUPLING NUTS OR FITTINGS.

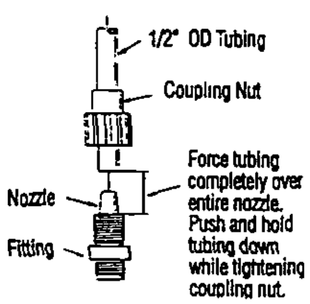
Tubing Connection
1/4" O.D. (.250") Tubing



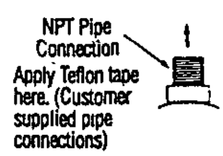
Tubing Connection
3/8" O.D. (.375") Tubing



Tubing Connection
1/2" O.D. (.5") Tubing



1/4" or 1/2" NPT Pipe Thread Connection



NOTE: See Metric Liquid Handling Sheet for metric tubing connections.

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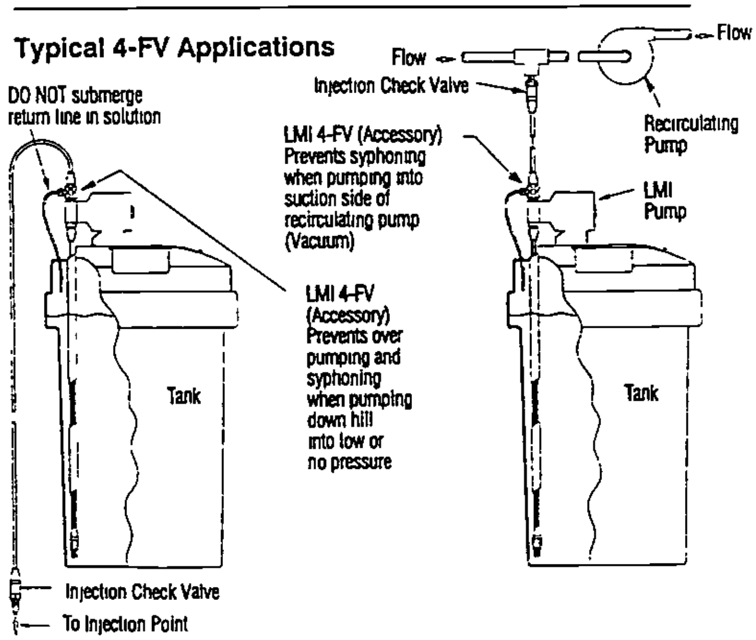
4.4 Four Function Valve (4-FV)

Some pump models come supplied with a 4-FV (pump models which end in "M"or"S"). If your pump is not equipped with this feature, and you feel it is needed in your application, it can be purchased as an accessory. Contact your local distributor for ordering information.

The functions of the 4-FV are:

1. **Anti-Syphon (automatic).**
   Prevents syphoning when pumping downhill or into a vacuum.
2. **Back Pressure (automatic).**
   Supplies approximately 25 psi back pressure to prevent over pumping when little or no system back pressure is present.
3. **Pressure Relief (automatic).**
   If discharge line is overpressurized, the valve opens sending the solution back to your supply tank.
4. **Line Depressurization (manual).**
   By pulling both knobs, the discharge line will drain back to your supply tank.

Typical 4-FV Applications



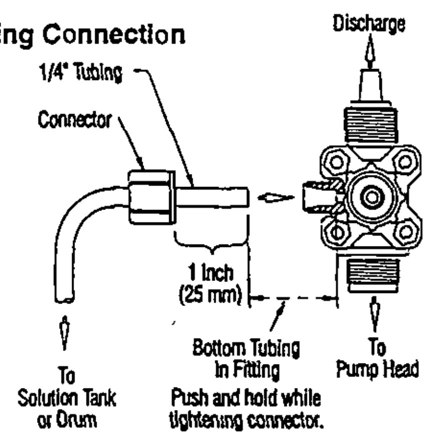
4.5 4-FV Installation

To install the 4-FV, remove the yellow screw cap on the top of the pump head and screw in the 4-FV so that the valve contacts the seal ring. An additional 1/8 - 1/4 turn may be necessary to prevent leakage. **DO NOT OVERTIGHTEN.** Overtightening can cause fittings and seal rings to distort, crack and function improperly.

1/4" O.D. tubing connects to the side of the 4-FV and acts as a return line to the solution tank. This tubing must **NOT** be submerged in the solution.

WARNING: This return line tubing must be secured to insure pumped solution will return to supply tank.

4-FV Tubing Connection



4.6 Foot Valve/Suction Tubing Straightener Installation

The Foot Valve acts as a check valve to keep the pump primed in suction lift applications.

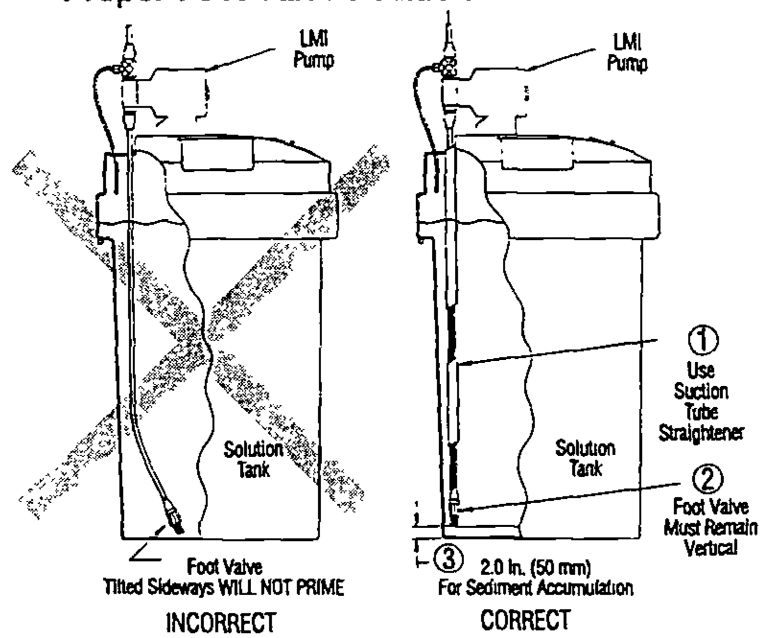
The valve is designed to be submersed in the solution tank or drum and must sit in a vertical position at the bottom. Position approximately 2 inches (50 mm) off the bottom if the tank or drum contains sediment.

685 163

The suction tubing straightener, when assembled, positions the foot valve and suction tubing in a vertical position.

1. Attach the foot valve to one end of the suction tubing (see Tubing Connections, section 4.3).
2. Assemble the suction tubing straightener by pushing together alternating yellow and black tubes. Adjust the length of the tubing straightener by pushing tubes further together so when placed over the suction tubing and sitting on the foot valve, approximately 3 inches (75 mm) of tubing exits the tubing straightener on the side to be connected to the pump.
3. Place foot valve, tubing and suction tubing straightener into the solution tank. Check that the foot valve is vertical and approximately 2 inches (50 mm) from the bottom of the tank or drum (see illustration). Connect the other end of the tubing to the suction side of the pump head (bottom side).

Proper Foot Valve Position



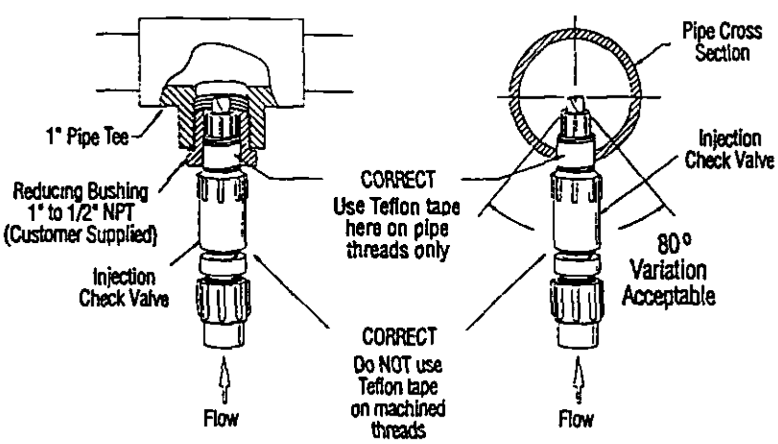
4.7 Injection Check Valve Installation

The Injection Check Valve prevents backflow from a treated line. Connect the Injection Check Valve to your "DISCHARGE" (outlet) line. Any size NPTF fitting or pipe tee with a reducing bushing to 1/2" NPTF will accept the injection check valve. Use Teflon tape or pipe dope to seal the pipe threads only.

When installing the Injection Check Valve, be sure to position it so that the valve enters the bottom of your pipe in a vertical position. Variations left and right within 80° are acceptable. (See illustration below)

After cutting an appropriate length of tubing, connect tubing to the injection check valve then back to the discharge side of the pump head (top side), making sure it does not crimp or come into contact with hot or sharp surfaces.

Typical Injection Check Valve Installations



685 165

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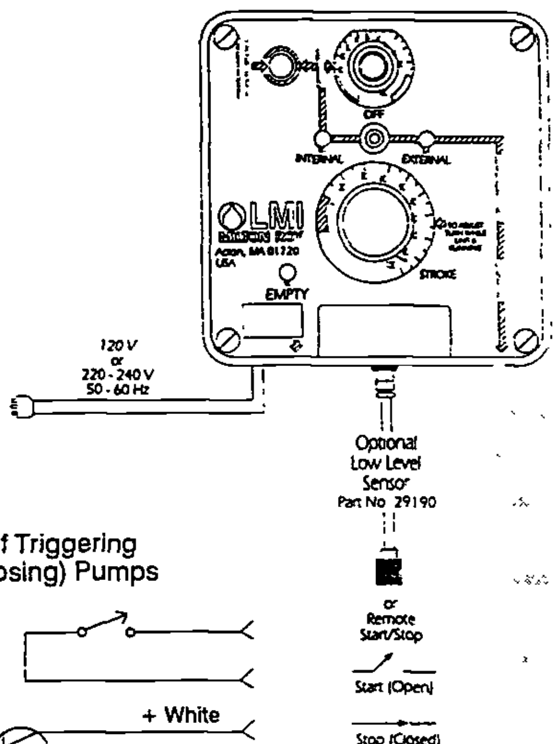
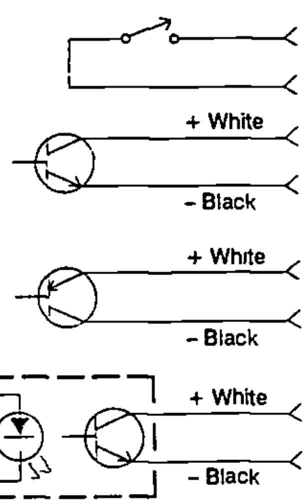
5.0 METHODS OF EXTERNALLY TRIGGERING OR



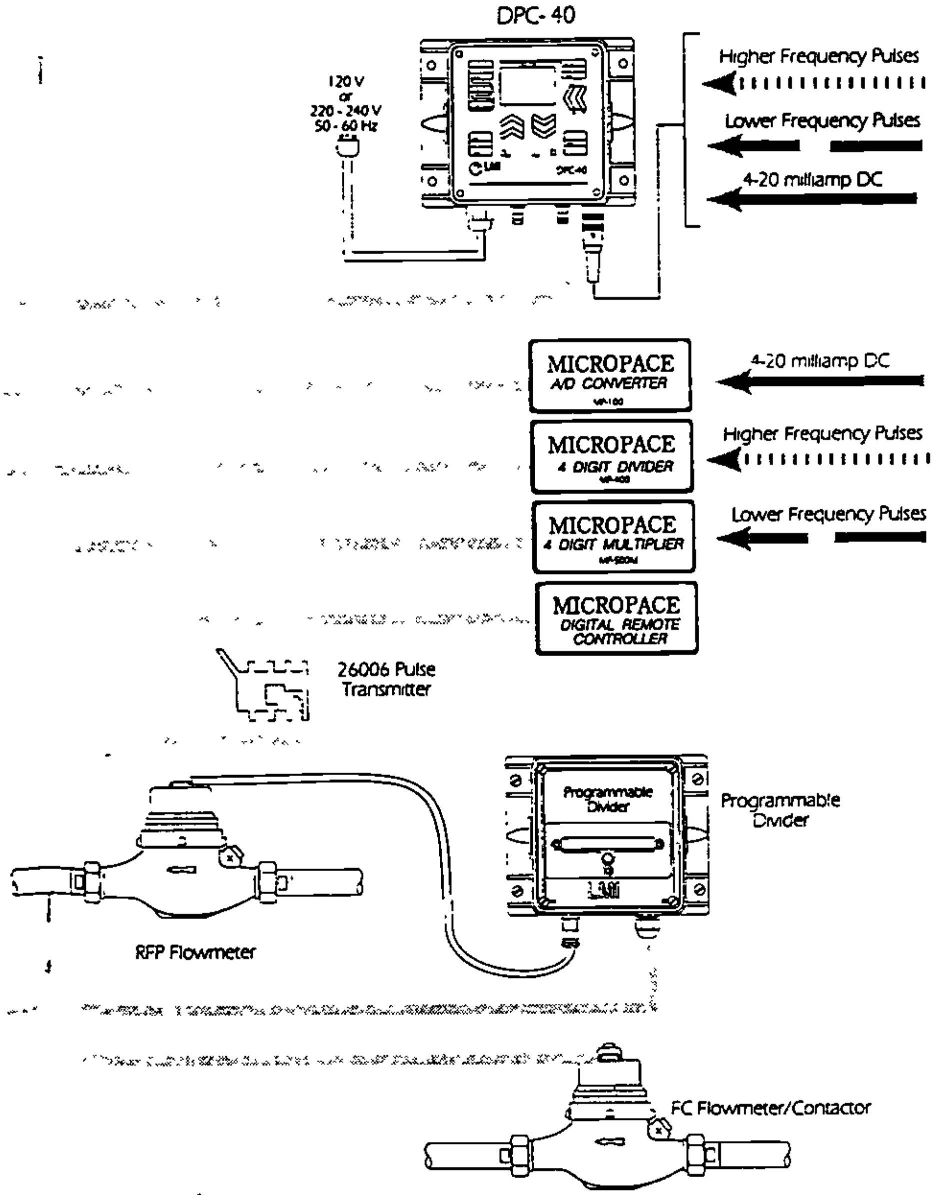
Methods of Triggering
Metering (Dosing) Pumps



1. Switch Closure
   Switch closing triggers pump
2. NPN Transistor
   Base goes high to trigger pump
3. PNP Transistor
   Base goes low to trigger pump
4. Opto Isolator

Note:
Switch or transistors must be capable of switching 15V DC at 2 milliamperes. Minimum time in low impedance state (on) is 50 milliseconds Minimum time in high impedance state (off) is 100 milliseconds.

OR PACING A7, B7, C7 AND D7 PUMPS



685 167

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6.0 START-UP and ADJUSTMENT

NOTE: The pump is normally self-priming if suction lift is 5 ft. (1.5m) or less and the steps below are followed.

NOTE: Pumps are shipped from the factory with water in the pump head to aid in priming.

6.1 Output Adjustment Controls

Note: Manual series pumps controls are not equipped with pressure control.

In most external controlled pumps the uppermost set of knobs on the control panel serve a dual purpose. The smallest of these knobs (inner knob of this concentric knob) is Pressure Control. The larger knob directly underneath is Speed Control. Graduation markings for the small Pressure Control Knob are etched in yellow on the Speed Knob itself. Graduations for the Speed Knob appear directly on the face of the control panel. The largest knob below is Stroke Control.

1. Pressure Control Adjustment: Pressure control provides the adjustment of the pump's pressure capability and power consumption, reducing heat, pipe shock and pulsation while increasing pump life. See Section 7.0 after priming for proper adjustment settings.

2. Speed Adjustment: Speed control provides adjustment of the percent of maximum strokes per minute. Turning this knob clockwise ↻ increases stroke frequency.

   Note A7 Series Only: When operating pump in external mode, the speed control knob should be turned fully counter clockwise ↺. A click indicates pump is in external mode.

   Note A34 and A37 Series Only: Pump comes equipped with a range selector switch which provides high or low speed adjustment. The high setting provides speed adjustments between 8-100 strokes per minute. The low setting provides accurate speed adjustments between 1-12.5 strokes per minute for applications requiring infrequent stroking.

3. Stroke Adjustment: Stroke control provides adjustment of percent of maximum Liquifram® (diaphragm) travel. Turning this knob clockwise increases percent output per stroke.

6.2 Start-Up/Priming for Pump Supplied with 4-FV

CAUTION: Read this entire section completely before proceeding.

When all precautionary steps have been taken, the pump is mounted, and the tubing is securely attached, you may now start priming the pump.

1. Plug in or switch the pump on.
2. While the pump is running, set the speed knob at 80% and the stroke knob at 100%.

   Note: If the pump is equipped with a pressure control knob, turn knob fully clockwise.
3. If your pump is equipped with a 4-FV, grip both the yellow and black knobs, 1/4 turn or pull and hold open.
4. The suction tubing should begin to fill with solution from the tank.
5. A small amount of solution will begin to discharge out the return line of the 4-FV. Once this happens, 1/4 turn or release the knobs and **SHUT THE PUMP OFF**. (If pump is not equipped with an on/off switch, disconnect the power cord.)

.685 169

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6. The pump is now primed.
7. Proceed to output adjustment, Section 6.4.

   NOTE: If the pump does not self-prime, remove the 4-FV on the discharge side of the pump head. Remove the ball and pour water or solution into the port until the head is filled. Replace valve, then follow start up/priming steps.

6.3 Start-Up/Priming without 4-FV

CAUTION: Read this entire section completely before proceeding.

When all precautionary steps have been taken, the pump is mounted, and the tubing is securely attached, you may now prime the pump.

1. Plug in or switch the pump on.
2. While the pump is running, set the speed knob at 80% and the stroke knob at 100%.

   Note: If the pump is equipped with a pressure control knob, turn knob fully clockwise.
3. The suction tubing should begin to fill with solution from the tank.
4. Once the solution begins to exit the pump head on the discharge side, **SHUT THE PUMP OFF**. (If pump is not equipped with an on/off switch, disconnect the power cord).
5. The pump is now primed.
6. Proceed to output adjustment, Section 6.4.

   NOTE: If the pump does not self-prime, remove the fitting on the discharge side of the pump head. Remove the ball and pour water or solution into the port until the head is filled. Replace valve, then follow start up/priming steps.

6.4 Output Adjustment

Once the pump has been primed, an appropriate output adjustment **MUST** be made. Pump output should be calculated and adjustments made accordingly.

TOTAL PUMP OUTPUT

Calculate the total output of the pump as follows:

PUMP OUTPUT = MAX PUMP OUTPUT x %SPEED x %STROKE

Example: A151-192S

Use MAX Output (From dataplate on bottom center of pump control panel) = 24 GPD (24 gallons per day).

If the pump is set at 60% speed and 70% stroke length, the approximate pump output is:

24.0 x 0.60 x 0.70 = 10.08 GPD (gallons per day) Divide by 24 (hours in one day) to calculate in gallons per hour.

Note: If pump is not equipped with speed adjustment, calculate by **Max Pump Output** x % **Stroke** only.

7.0 CALIBRATION

Once installation is complete and the approximate output has been determined, the pump should be calibrated to adjust speed and stroke for your actual desired output.

1. If equipped, make certain Pressure Control Knob is turned fully clockwise.
2. Be sure the pump is primed, and discharge tubing and Injection Check Valve are installed as they would be in normal service (i.e., including factors such as injection pressure, fluid viscosity, and suction lift).

685 171

3. Place the Foot Valve in a graduated container with a volume of 1000 ml or more.

4. Plug in and switch pump to Internal Mode. Pump until all the air is exhausted from the suction line and head.

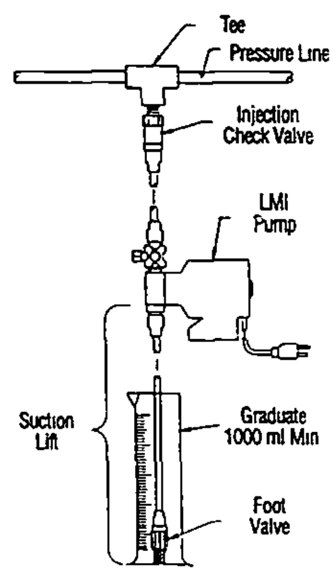
5. Turn the pump off. Refill graduated container to a level starting point.

   NOTE: If pump is equipped with pressure control, see Section 7.1 before proceeding.

6. Using a stopwatch or timer, turn the pump on for a measured amount of time (50 pump strokes minimum). The longer the time period, the more confident you can be of the results. Be sure to count the number of strokes during the calibration period when making comparisons.

7. Turn the pump off. Note the time elapsed in relation to volume displaced in the graduate. Now, calculate the output in the time unit you choose (minutes, hours. days, etc.).

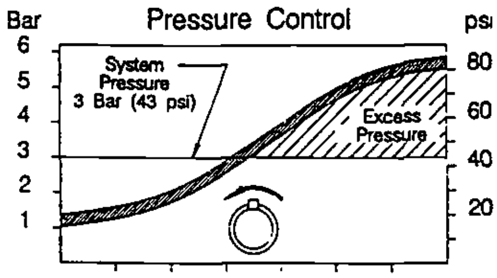
8. If the output is too low or too great, adjust speed and or stroke, estimating required correction and repeat steps 1-7.



7.1 Pressure Control

Adjust Pressure Control: While unit is running, turn Pressure Control Knob slowly counter-clockwise until unit just begins to stall. From this stall point, now turn Pressure Control Knob clockwise from 1 to 1 ½ graduation marks. This is the optimum pressure control setting for your application.

NOTE: Increase setting if back pressure is increased.



Adjust pressure control to reduce heat, shock, pulsations and prolong pump life.

7.2 Calibration Procedure - On-Site Volumetric Calibration in External Mode

1. Since pump output is governed by an external device such as Flowmeter-Pulser, Liquitron™ Current-to-Frequency Converter or 4-20 mA DC signal from an instrument with an LMI Analog-to Digital Converter, **only the output per stroke may be calibrated.**
2. With pump primed and discharge tubing connected to the injection point as it would be in normal service, place Foot Valve and Strainer Assembly in a graduated container with a volume of 500 ml or more.
3. Switch pump to **Internal** mode with Speed Knob set at 100 until air is exhausted from suction line and pump head.

685 173

4. **Adjust Pressure Control** - See Section 7.1.
5. Switch pump **OFF** and note solution level in graduated container. Refill graduate to a starting point.
6. Switch pump **ON** and **count the number of strokes** for exactly one minute. Then Switch pump **OFF**.
7. Note volume pumped during the calibration period of one minute. Divide into this the number of strokes to determine the volume of solution pumped per stroke.

   Example: 500 ml in 100 strokes = 5.0 ml per stroke.

   Multiply this by your expected stroke rate per minute, per hour or per day and compare with desired output requirements.
8. Adjust Stroke Length Knob (lower knob) to your best estimate of required correction and repeat calibration procedure.

8.0 SPARE PARTS REPLACEMENTS ROUTINE MAINTENANCE

8.1 Depressurizing the Discharge Line (For Pumps Equipped with a 4-FV only).

WARNING: ALWAYS wear protective clothing, face shield, safety glasses and gloves when performing any maintenance or replacement on your pump.

WARNING: Read steps 1 and 2 below before proceeding.

1. Be sure the Injection Check Valve is properly installed and is operating. If a shut off valve has

been installed downstream of the Injection Valve, it should be closed to off.

WARNING: Be sure your relief tubing is connected to your 4-FV and runs back to your solution drum or tank.

2. 1/4 turn or pull on both the yellow and black knobs on the 4-FV. The discharge line is now depressurized. Keep valve open until solution drains back down the discharge tubing into solution drum or tank. Then release or 1/4 turn knobs to normal position.

8.2 Liquifram® (Diaphragm) Replacement

WARNING: ALWAYS wear protective clothing, face shield, safety glasses and gloves when working near or performing any maintenance or replacement on your pump. See MSDS Sheet from solution supplier for additional precautions.

LMI metering pumps are designed for trouble-free operation, yet routine maintenance of elastomeric parts is essential for optimum performance. This involves replacing the Liquifram® seal rings, valve balls, and the Injection Check Valve spring. LMI recommends replacing these parts at least once a year, however, frequency will depend on your particular application.

When replacing the Liquifram®, the valve balls, seal rings and the injection check valve spring should also be replaced. See next section (8.3). A Spare Parts Kit (SP-#) containing these parts may be obtained from your local distributor. (See the Liquid Handling Assembly Sheet for Spare Parts Kit Part Number).

685, 175

1. Carefully depressurize, drain, and disconnect the discharge line (See Section 8.1 in this manual). Place the Foot Valve into a container of water or other neutralizing solution. Turn the pump on to flush the head assembly. Once the pump head has been flushed, lift the Foot Valve out of the solution and continue to pump air into the pump head until the pump head is purged of water or neutralizing solution.

   Note: If the liquid cannot be pumped due to Liquifram® rupture, using protective gloves, carefully disconnect the suction and discharge tubing. Remove the four screws to the head and immerse the head in water or other neutralizing solution.

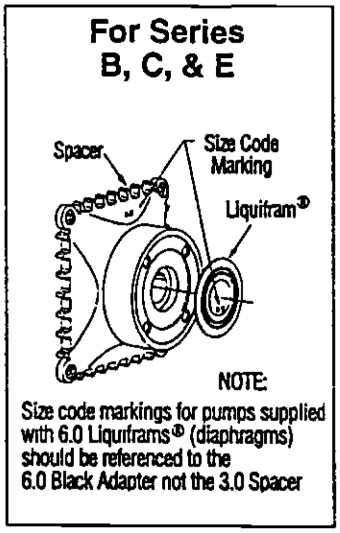
2. Start the pump. While running, set the stroke knob to zero and turn the pump off.

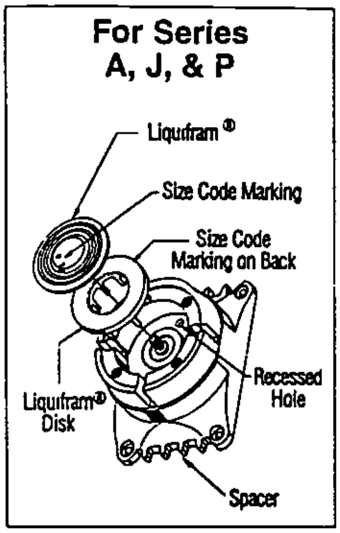
   NOTE: See Section 9.0 for proper zeroing.

3. With the unit off, unscrew the Liquifram® by carefully grasping the outer edge of the Liquifram® and turning it counter clockwise. Discard old Liquifram®. Remove the Liquifram® disk if so equipped (located behind the Liquifram®) and check that the size code matches the size code on the replacement Liquifram® (see illustration).

4. Reinstall the disk so the alignment pin on the disk (if present) seats in the recessed hole in the EPU.

WARNING: Take care not to scratch the Teflon face of the new Liquifram®.





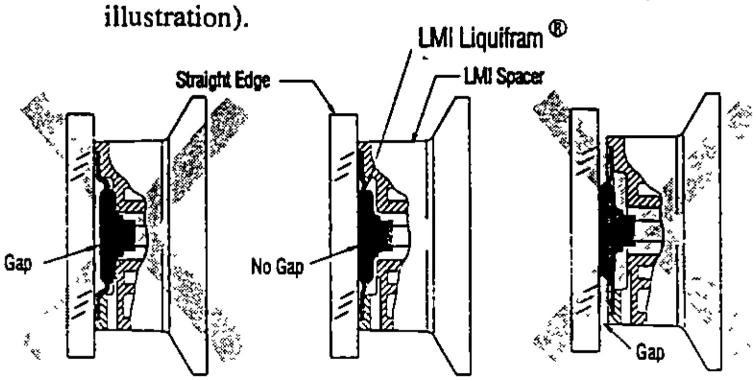
5. Start the pump and turn the stroke knob to the setting indicated below on Stroke Setting Chart which matches the pump model number located on the pump dataplate. With the pump stroking (running), screw on the new Liquifram® clockwise until the center begins to buckle inwards. Stop the pump.

Liquifram® Stroke Setting Chart

Pump Series	Stroke Knob Setting
All A, B, J, P, Z Series C10, C11, C12, C70, C71, C72, E70, E71, E72	90%
All L Series,	85%
C78	50%
C13, C14, C73, C74, C77 E73, E74	70%
All U and M Senes	100% but Liquifram® must be bottomed completely. (Turned all the way) **Do Not Use Straight Edge.**

685 177

6. Grasp the outer edge of the Liquifram® and adjust by screwing it in or out so that the center of the Liquifram® is flush with the outside of the spacer edge (see illustration).



7. Once the Liquifram® is properly positioned, remount the pump head to the spacer using the four (4) screws. Tighten in a crisscross pattern. After one week of operation, recheck the screws and tighten if necessary.

8.3 Seal Ring, Ball and Injection Check Valve Spring Replacement

WARNING: ALWAYS wear protective clothing, face shield, safety glasses and gloves when working on or performing any maintenance or replacement on your pump. See MSDS Sheet from solution supplier for additional precautions.

1. Refer to the Liquid Handling Assembly Sheet included with your pump for the proper Spare Parts Kit number.

2. Carefully depressurize and disconnect the discharge line (See Section 8.1 in this manual). Place the Foot Valve into a container of water or other neutralizing solution. Turn the pump on to flush the head assembly.

Once the pump has been flushed, lift the Foot Valve out and continue to pump to let air into the pump head until pump is purged of water or neutralizing solution.

If the liquid cannot be pumped due to Liquifram® rupture, with protective gloves, carefully disconnect the tubing and four screws to remove the head. Immerse the head in water or other neutralizing solution.

IMPORTANT: Before disassembling valves, note the orientation of seal ring and ball. (See illustration)

3. Carefully disconnect one tubing connection and fitting at a time and remove the worn seal ring and ball.

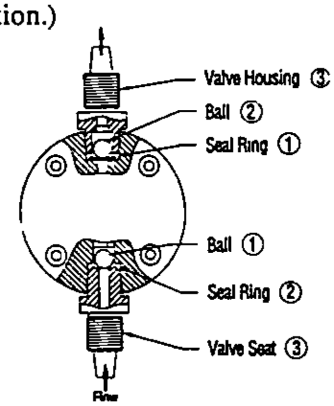
   Carefully loosen sealing by prying side to side using a small screw driver through the center hole of the seal ring.

4. Install new seal ring and ball in each location. IMPORTANT: Note correct orientation.

5. Install the new spring in the Injection Check Valve.

WARNING: Depressurize and drain pipeline (or isolate I.C.V. point using valves) so that I.C.V. can safely be disassembled.

(Refer to Liquid Handling End Sheet for proper assembly orientation.)



Order of Installation

Note: Order of assembly changes depending on valve location

685 179

9.0 CHECKING PUMP FOR PROPER ZEROING (STROKE KNOB)

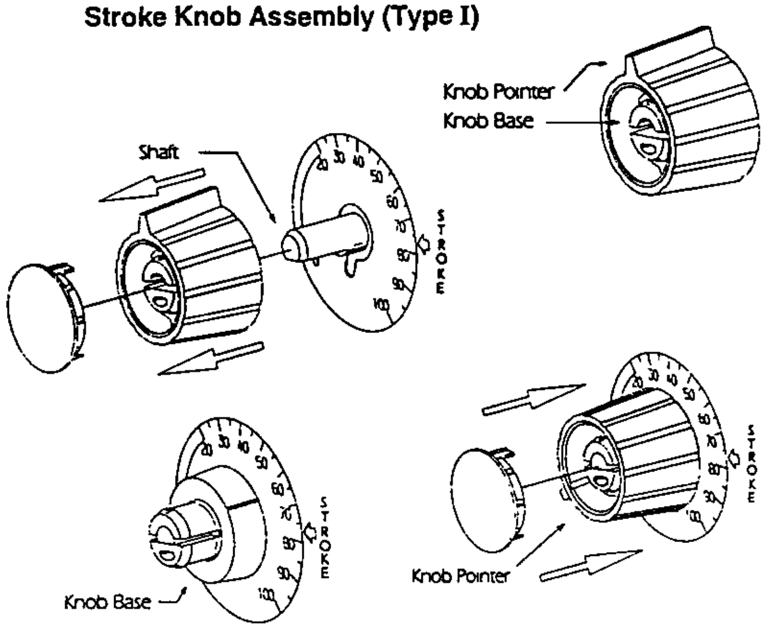
1. With pump running, turn stroke knob counter clockwise toward zero or end of black or red band.
2. LISTEN to the clicking as the pump is running. The pump should operate quietly at the zero position (no clicking).
3. If the pump continues to click at zero or stops clicking before zero is reached, the pump zero must be reset (See Section 9.1 or 9.2)

9.1 Type I - Push on Knob

Rezeroing and Stroke Knob Disassembly and Assembly

1. Remove stroke knob from the pump by grasping the knob firmly and pulling it toward you.
2. Pry off the yellow cap.
3. Place the knob on a flat surface.
4. Using needle nose pliers, squeeze the inner section together while lifting the outer section up.
5. Push the inner section back onto the "D" shaped stroke shaft.
6. With the pump running, zero the pump by turning the inner section of the knob counter clockwise until the pump stops clicking.
7. Position the outer section of the knob so that the pointer aligns with zero on the nameplate or end of the black or red band.
8. Push down on the outer section (a snap sound indicates parts are locked together).
9. Replace the yellow cap over the outer section of the knob, aligning the tabs on the cap with the slots inside the knob.

Stroke Knob Assembly (Type I)



9.2 Type II Collet Knob

Rezeroing and Stroke Knob Disassembly and Assembly

1. Remove Yellow Cap.
2. Hold knob with soft jaw pliers.
3. Disconnect knob by loosening 5/16" (8 mm) collet nut. There is no need to remove nut.
4. Remove knob by pulling towards you.
5. With pump running, zero the pump using a screw driver to turn the stroke shaft counter-clockwise until the pump just stops clicking.
6. Pump is now zeroed.
7. Position knob at zero, or the end of the low range band, and tighten 5/16" (8 mm) collet nut).
8. Replace yellow cap.

685 181

10.0 TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE
Pump Will Not Prime	1. Pump not turned on or plugged in.
	2. Output dials not set properly.
	3. Foot Valve not in vertical position on bottom of tank.
	4. Pump suction lift too high.
	5. Suction tubing is curved or coiled in tank
	6. Fittings are over tightened.
	7. Air trap in suction valve tubing.
	8. Too much pressure at discharge. (Pumps without 4-FV)
Pump Loses Prime	1. Solution container ran dry
	2. Foot Valve is not in a vertical position on the bottom of the tank.
	3. Pump suction lift is too high.
	4. Suction tubing is curved or coiled in tank.
	5. Fittings are overtightened.
	6. Air trap in suction valve tubing.
	7. Air leak on suction side.

	SOLUTION
	1. Tum on pump/plug in pump.
	2. Always prime pump with speed at 80% and stroke at 100%.
	3. Foot Valve must be vertical (See Foot Valve Installation, Section 4.6).
	4. Maximum suction lift is 5 ft. (1.5 m) Pumps with High Viscosity Liquid Handling Assemblies require flooded suction.
	5. Suction tubing must be vertical. Use LMI tubing straightener supplied with pump. (See Section 4.6)
	6. Do not overtighten fittings. This causes seal rings to distort and not seat properly which causes pump to leak back or lose prime.
	7. Suction tubing should be as vertical as possible. AVOID FALSE FLOODED SUCTION! (See Section 4.2A)
	8. Shut off valves in pressurized line. Disconnect tubing at injection check valve (See priming Section 6.0). When pump is primed, reconnect discharge tubing.
	1. Refill container with solution and reprime (See Section 6.0)
	2. Foot Valve must be vertical (See Foot Valve Installation, Section 4 6).
	3. Maximum suction lift is 5 ft. (1.5 m). Pumps with High Viscosity Liquid Handling Assemblies require flooded suction.
	4. Suction tubing must be vertical. Use LMI tubing straightener supplied with pump. (See Section 4.6)
	5. Do not overtighten fittings. This causes seal rings to distort and not seat properly which caused pump to leak back or lose prime.
	6. Suction tubing should be as vertical as possible. AVOID FALSE FLOODED SUCTION! (See Section 4.2A)
	7. Check for pinholes, cracks. Replace if necessary.

685, 183

TROUBLESHOOTING (continued)

PROBLEM	POSSIBLE CAUSE
Leakage at tubing	1. Worn tubing ends.
	2. Loose or cracked fitting.
	3. Worn seal rings.
	4. Solution attacking Liquid Handling Assembly material.
Low Output or Failure to Pump Against Pressure	1. Pump's maximum pressure rating is exceeded by injection pressure.
	2. Worn Seal Rings.
	3. Ruptured Liquifram®.
	4. Incorrect stroke length.
	5. Tubing run on discharge may be too long.
	6. Clogged footvalve strainer.
Failure to Run	1. Pump not turned on or plugged in.
	2. EPU failure.
	3. Pulser failure.
Excessive Pump Output	1. Syphoning. (Pumping downhill without a 4-FV).
	2. Little or no pressure at injection point.
	3. Excessive strokes per minute.

SOLUTION
1. Cut tubing about 1inch (25 mm) off tubing and then replace as before.
2. Replace fitting if cracked. Carefully hand tighten fittings. Do not use pipe wrench. Once fitting comes into contact with seal ring, tighten an additional 1/8 or 1/4 turn.
3. Replace balls and seal rings. (See Section 8.3) Spare Parts (SP-#)
4. Consult LMI or your local distributor for alternate materials.
1. Injection pressure cannot exceed pump's maximum pressure. See pump data plate.
2. Worn seal rings may need replacement. (See Section 8.3) Spare Parts (SP-#)
3. Replace Liquifram®. (See Section 8.2)
4. Check zero on pump/Re-zero pump. (See Section 9.0)
5. Longer tubing runs may create frictional losses sufficient to reduce pump's pressure rating. Consult factory for more information.
6. Remove footvalve strainer when pumping slurries or when solution particles cause strainer to clog.
1. Turn on or plug in pump.
2. Disassemble pump and measure the resistance of the EPU across the EPU wires. Resistance reading should be in accordance to the table (See Section 11.0). Also check EPU leads to ground. Consult supplier or factory.
3. The pulser should be replaced if EPU checks out OK. Consult supplier or factory.
1. Move injection point to a pressurized location or install an LMI 4-FV. (See Section 4.4)
2. If pressure at injection point is less than 25 psi, an LMI 4-FV should be installed. (See Section 4.4)
3. Replace pulser or resistor. Consult factory.

685 185

11.0 EPU RESISTANCE CHART

Pump Series	Voltage	Coil Resistance (Ohms) * @ 20°C (68° F)
A14, A15, A16, A34, A74, A75, A76 A94, A95, A96 J02, J03, J04 , J05, J06 J13, J15, J16 PW4, PW5, PW6 P04, P05, P06 P14, P15, P16 U01,U02,U03	115 VAC 230 VAC	76 - 87 307 - 353
A17,A37,A77,A97,A18,A78 P02,P03 P12,P13 (NOTE 1)	115 VAC 230 VAC	152 - 176 583 - 671
A17, A37, A77, A97, A18, A78 P02, P03 P12,P13,P77 (NOTE 2)	115 VAC 230 VAC	76- 87 291- 335
J54D, J55D, J56D	12 VDC	1.1 - 1 3
D10, D11, D12, D13, D14 D70, D71, D72, D73, D74	115 VAC 230 VAC	25.7- 29.6 97 - 112
E70, E71, E72, E73, E74	115 VAC 230 VAC	22.8 - 26.2 91 - 105
B11, B12, B13, B14 B71, B72, B73, B74	115 VAC 230 VAC	43 - 49 167 - 193
C10, C11, C12, C13, C14 C70, C71, C72, C73, C74	115 VAC 230 VAC	22 8 - 26 2 91 - 105
C77, C78	115 VAC 230 VAC	14.4 - 16.6 57.7 - 66.3

NOTES
1 Pumps with serial numbers lower than 960113429
2. Pumps with serial numbers higher than 960113429

* EPU checked within 10 hours of operation can increase coil resistance reading as much as 20%

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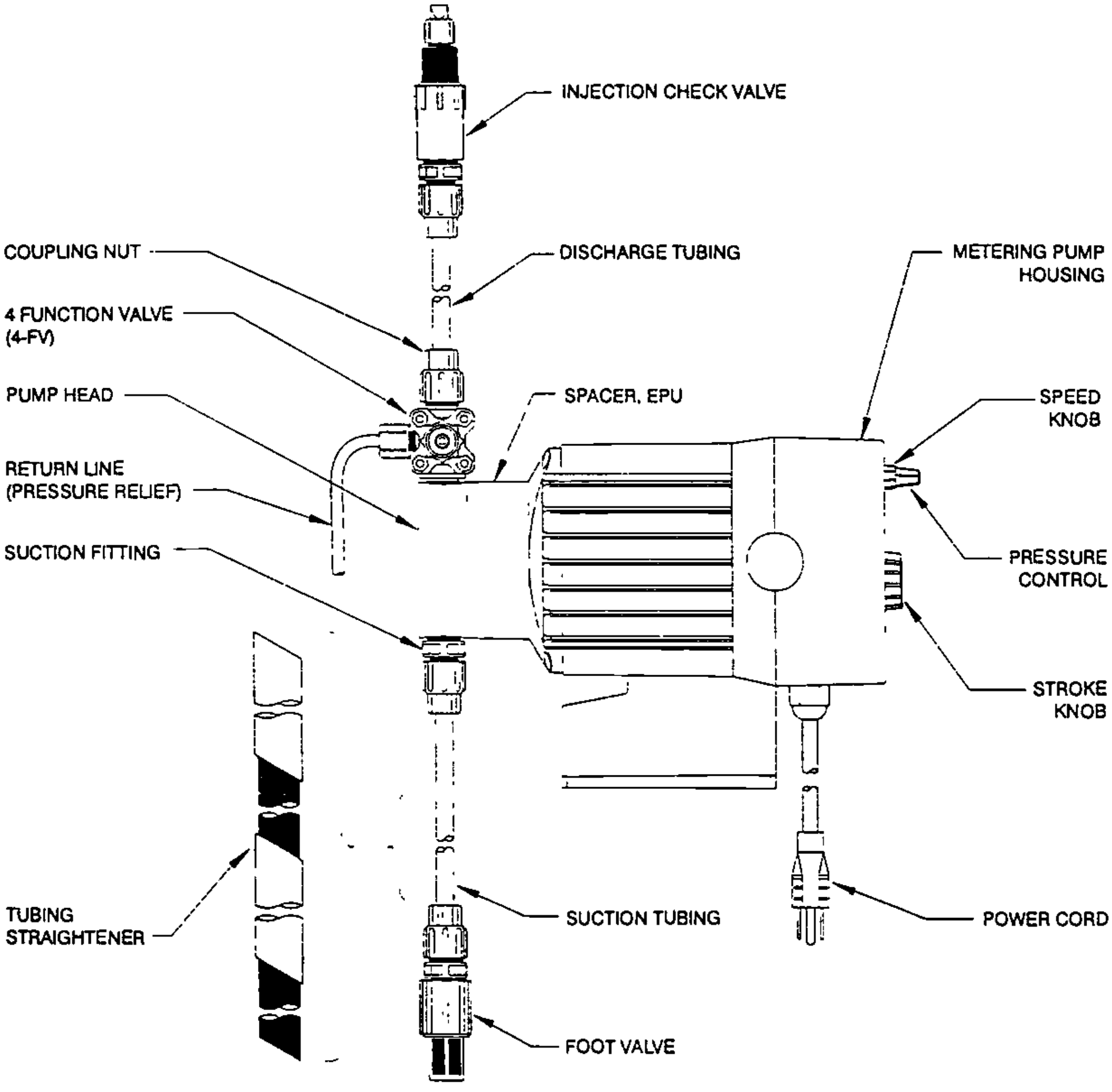
Instruction **Supplement**

Series C7
Electronic Metering Pump



Metering Pump Component Diagram

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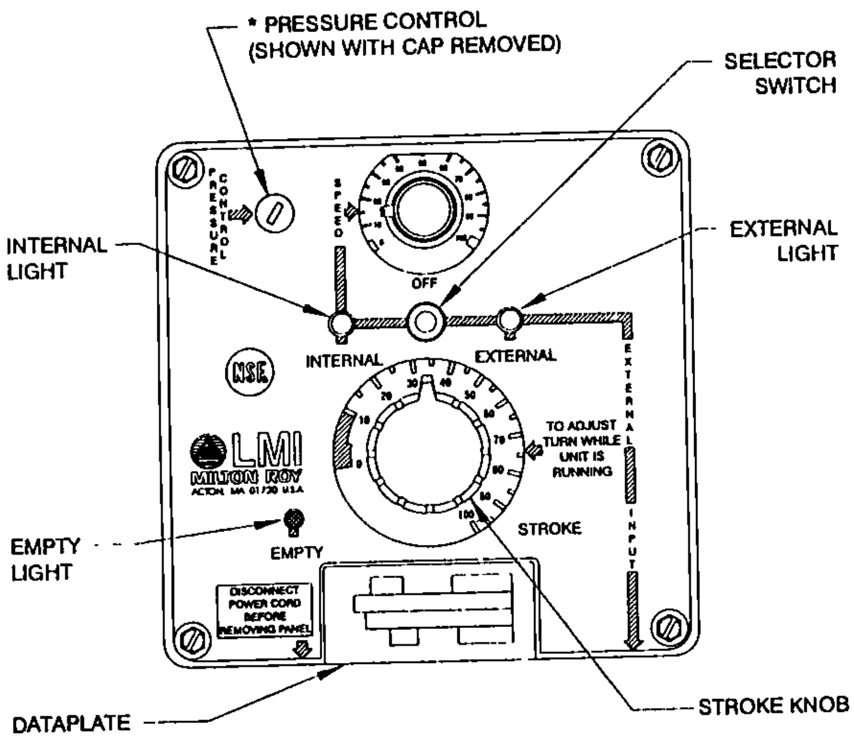
http: //www.lmipumps.com

ISO9001

Replaces same of 1716 D 4/96
1716 E 5/97

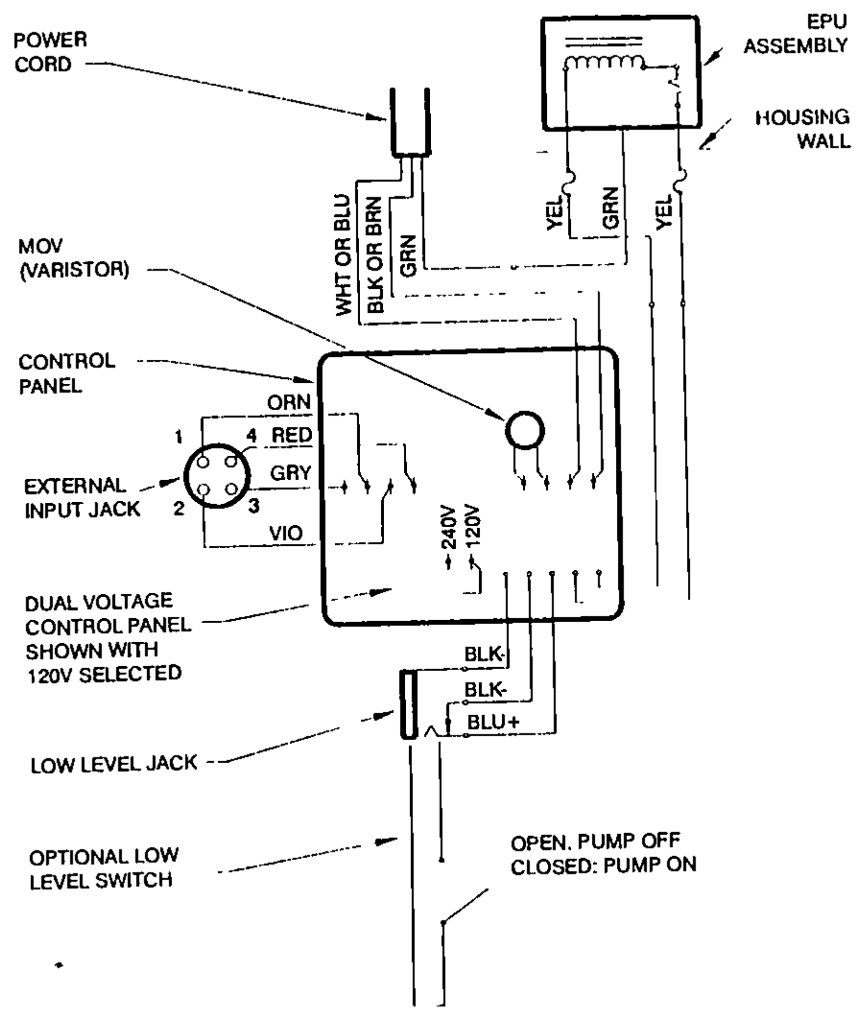
685 187

Series C7 Control Panel Detail

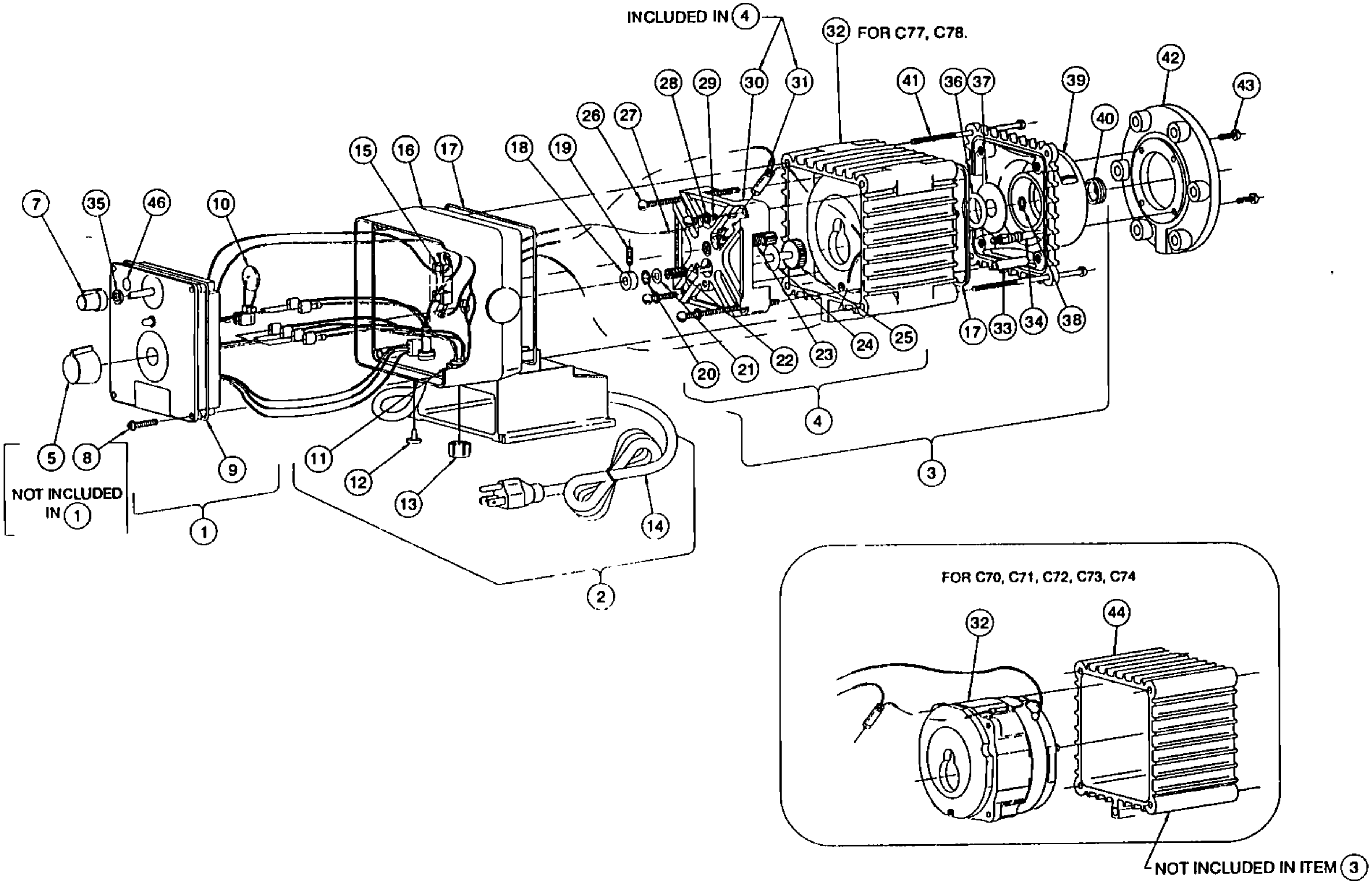


*To adjust pressure control: Remove yellow cap. With small screwdriver, and the pump running, turn the pressure control adjustment slowly counterclockwise until pump just begins to stall. From this stall point, turn clockwise approximately 30 degrees. This is the optimum pressure control setting for your application.

Series C7 Wiring Diagram



Series C7 Drive Assembly Exploded View Diagram



685 188

Series C7 Drive Assembly Parts List

Key No.	Model Series	Part No.	Description	Qty
1	C701, C711	33814	Control Panel Assembly, 120V	1
	C702, C703, C705, C706, C707 C712, C713, C715, C716, C717	33815	Control Panel Assembly, 240V	1
	C721	33816	Control Panel Assembly, 120V	1
	C722, C723, C725, C726, C727	33817	Control Panel Assembly, 240V	1
	C731	33818	Control Panel Assembly, 120V	1
	C732, C733, C735, C736, C737	33819	Control Panel Assembly, 240V	1
	C741	33820	Control Panel Assembly, 120V	1
	C742, C743, C745, C746, C747	33821	Control Panel Assembly, 240V	1
	C771	33211	Control Panel Assembly, 120V	1
	C772, C773, C775, C776, C777	33212	Control Panel Assembly, 240V	1
	C781	33822	Control Panel Assembly, 120V	1
	C782, C783, C785, C786, C787	33823	Control Panel Assembly, 240V	1
2	C701, C711, C721, C731, C741	32401	Housing Assembly, 120V	1
	C702, C712, C722, C732, C742	32402	Housing Assembly, 240V	1
	C703, C713, C723, C733, C743	32403	Housing Assembly, 220-240V	1
	C705, C715, C725, C735, C745	32404	Housing Assembly, 220-240V, U.K	1
	C706, C716, C726, C736, C746	32405	Housing Assembly, 220-240V, Aust.	1
	C707, C717, C727, C737, C747	32406	Housing Assembly, 220-240V, SWISS	1
	C771, C781	32252	Housing Assembly, 120V	1
	C772, C782	32502	Housing Assembly, 240V	1
	C773, C783	32253	Housing Assembly, 220-240V	1
	C775, C785	32503	Housing Assembly, 220-240V, U.K.	1
	C776, C786	32504	Housing Assembly, 220-240V, Aust	1
	C777, C787	32505	Housing Assembly, 220-240V, SWISS	1
3	C701	32532	EPU & Spacer Asm, w/Stroke Adj ,120V	1
	C702, C703, C705, C706, C707	32533	EPU & Spacer Asm, w/Stroke Adj , 240V	1
	C711, C721	32534	EPU & Spacer Asm, w/Stroke Adj , 120V	1
	C712, C713, C715, C716, C717 C722, C723, C725, C726, C727	32535	EPU & Spacer Asm, w/Stroke Adj , 240V	1
	C731, C741	32536	EPU & Spacer Asm, w/Stroke Adj , 120V	1
	C732, C733, C735, C737, C742, C743, C745, C747	32537	EPU & Spacer Asm, w/Stroke Adj , 240V	1
	C771	32329	EPU & Spacer Asm, w/Stroke Adj ,120V	1
	C772, C773, C775, C776, C777	32330	EPU & Spacer Asm, w/Stroke Adj ,240V	1
	C781	32331	EPU & Spacer Asm, w/Stroke Adj , 120V	1
	C782, C783, C785, C786, C787	32332	EPU & Spacer Asm, w/Stroke Adj ,240V	1
4	C7	32251	Stroke Bracket Assembly	1
5	C7	31891	Knob, Stroke	1
7	C7	30709	Knob, Speed	1
8	C7	30306	Screw, 10 x 1PH S S.	4
9	C7	10166	O-Ring	1
10	C7X1	10626	MOV Assembly, 120V	1
	C7X2, C7X3, C7X5, C7X6, C7X7	10627	MOV Assembly, 220-240V	1
11	C7	28907	Jack Assembly	1
12	C7	30307	Plug	1
13	C7	25930	Cover	1
14	C7X1	26293	Power Cord Assembly, 120V	1
	C7X2	26296	Power Cord Assembly, 240V	1
	C7X3	26297	Power Cord Assembly, 220-240V, DIN	1

Key No.	Model Series	Part No.	Description	Qty
	C7X5	26817	Power Cord Assembly, 220-240V, UK	1
14	C7X6	26818	Power Cord Assembly, 220-240V, AUST	1
	C7X7	27701	Power Cord Assembly, 220-240V, SWISS	1
15	C701, C711, C721, C731, C741	25825	Fuse, 4A Rectifier	2
	C771, C781	32254	Fuse, 10A Rectifier	2
	C70, C71, C72, C73, C74 All models rated 220-240 Volts	25824	Fuse, 2A Rectifier	2
	C77, C78 All models rated 220-240 Volts	32255	Fuse,5A Rectifier	2
16	C7	28925	Housing	1
17	C7	35269	O-Ring	2
18	C7	25424	Collar	1
19	C7	25423	Set Screw	1
20	C7	10462	Retaining Ring	1
21	C7	32302	Washer	1
22	C70, C71, C72 , C73, C74	25414	Spring	1
	C77, C78	32221	Spring	1
23	C7	32578	Pinion	1
24	C7	25121	Gasket	1
25	C7	31770	Shaft Assembly	1
26	C7	27552	Screw, 10-24x4 0	2
27	C7	27693	Ground Wire Assembly (GRN)	1
28	C7	10415	Washer	4
29	C7	27551	Screw, 10-24x1 25	4
30	C7	12064	Bracket *(without mating parts)*	1
31	C7	27501	Thermostat	1
32	C701, C711, C721, C731, C741	32158	EPU Assembly, 120V	1
	C70, C71, C72 , C73, C74 All models rated 220-240 Volts	32159	EPU Assembly, 240V	1
	C771	32239	EPU Assembly, 120V	1
	C77, All models rated 220-240 Volts	32240	EPU Assembly, 240V	1
	C781	32314	EPU Assembly, 120V	1
	C78, All models rated 220-240 Volts	32315	EPU Assembly, 240V	1
33	C70, C71, C72 , C73, C74	27187	Spacing Stud	2
	C77, C78	32247	Spacing Stud	2
34	C70, C71, C72	27641	Stud Assembly	4
	C73, C74, C77, C78	27641-1	Stud Assembly	4
35	C7	30803	Gasket	1
36	C7	26983	O-Ring	1
37	C7	27586	Shim	1
38	C7	27253	Retaining Ring	1
39	C70	27515	Spacer, 0.9 SI	1
	C71, C72	27516	Spacer, 1.8 SI	1
	C73, C74	27517	Spacer, 3.0 SI	1
	C77, C78	35839	Spacer, 3.0 SI	1
40	C7	10973	Seal	1
41	C7	25127	Screw, RH Slotted, S.S	4
42	C74, C78	25887	Spacer Adapter, 6 0 SI	1
43	C7	10598	Screw	4
44	C70, C71, C72 , C73, C74	25068	Sleeve, EPU	1
not shown	C7	25849	Bushing, Unipulser	1
46	C7	29093	Cap	1

LE-71T LE-72T LE-75T LIQUID HANDLING ASSEMBLIES

CAUTION

When pumping chemicals make certain that all tubing is securely attached to the fittings. It is recommended that tubing or pipe lines be shielded to prevent possible injury in case of rupture or accidental damage. Always wear protective clothing when working on or near chemical metering pump.

A. INSTALLING INJECTION CHECK/BACK PRESSURE VALVE

1. The injection check valve should always be installed as close as possible to the point of chemical injection, at the very end of the tubing run.
2. Purpose of injection check/back pressure valve is to prevent backflow from *treated line* and to prevent syphoning or overpumping of chemical.
3. A 1/2" NPT female fitting with sufficient depth will accept the injection check/back pressure valve.
4. To insure correct seating of the ball inside the check valve, the injection check/back pressure valve should be installed upwards.

B. CONNECTING DISCHARGE TUBING

1. Discharge tubing is relatively stiff translucent tubing.
2. Route tubing from injection check valve to chemical metering pump, making sure it does not touch hot surfaces, sharp surfaces, or is bent so sharply that it kinks.
3. Slide small end of coupling nut onto tubing.
4. Push tubing over tapered nozzle of discharge valve so that tubing flares out and reaches the shoulder. (If tubing is stiff from cold, dip end in hot water.)
5. Slide down the coupling nut until threads are engaged. Tighten by hand until tubing is held securely in place.

Excessive force will crack or distort fittings. DO NOT USE PIPE WRENCH.

6. Follow the same procedure for connecting tubing to injection valve.

C. CONNECTING SUCTION TUBING

1. Cut suction tubing to a length such that the foot valve hangs just above the bottom of the chemical container. Maximum recommended vertical suction lift is 5 ft. (1.5m).
2. Follow same procedure (see B) in connecting suction tubing to suction valve and foot valve.
3. If a suction tube straightener is desired, one may be fabricated from a 3 ft. (1m) piece of 3/4" Schedule 80 PVC pipe.
4. Dip end of PVC pipe in hot water for at least 1 minute to fit easily over end of coupling nut.
5. Push pipe over small end of coupling nut.

D. PRIMING

1. Temporarily remove tubing from injection check/back pressure valve and hold the end of tubing so it is above pump level.
2. Set pump at 80% speed and 100% stroke and start pump.
3. As soon as chemical is visible through translucent discharge tubing just past the discharge valve, stop the pump.
4. Pump is now primed.
5. Reconnect tubing to injection check/back pressure valve.

NOTE:

(a) Pump is normally self-priming if suction lift is no more than 5 ft. (1.5m), valves in the pump are wet with water (pump is shipped from factory with water in pump head and therefore valves are wet), and the above steps (D1 thru D3) are followed.

(b) If the pump does not self-prime, remove discharge valve housing and ball and pour water or chemical slowly into discharge port until it is filled. Follow steps D2 thru D5 thereafter.

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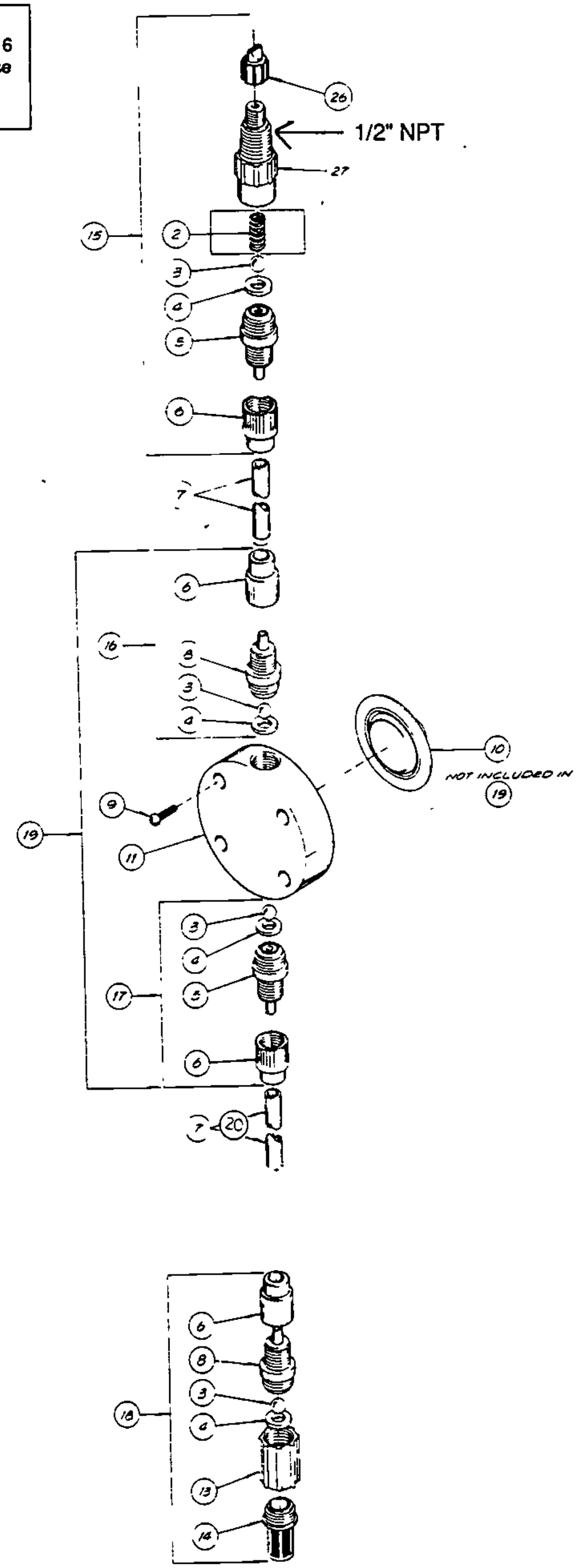
KEY NO.	PART NO.	DESCRIPTION	QUANTITY LE-71T	LE-72T	LE-75T
2	29339*	Spring	1		
	10339*	Spring		1	1
3	10338*	Ball, Ceramic	4	4	4
4	10407*	Seal Ring, Teflon	4	4	4
5	10492	Valve Seat, PVC	2	2	
	10792	Valve Seat, Ivory, Polypropylene			2
6	10411	Coupling Nut	4	4	4
7	10142-10	Tubing, Polyethylene, .5" O.D.	1		
	10142-16	Tubing, Polyethylene, .5" O.D.		1	1
8	10493	Valve Housing, PVC	2	2	
	10793	Valve Housing, Ivory Polypropylene			2
9	10340	Screw, 10-24 x 3/4" S.S.	4	4	4
10	10305*	Liquifram, 1.8 SI, Teflon Face	1	1	1
11	10104	Head, 1.8 SI, Acrylic	1		
	10204	Head, 1.8 SI, PVC		1	
	10304	Head, 1.8 SI, Ivory, Polypropylene			1
13	10978	Foot Valve Seat	1	1	1
14	10123	Strainer, Polypropylene	1	1	1
15	25687	Injection Check/Back Pressure Valve Asm	1		
	25203	Injection Check/Back Pressure Valve Asm		1	
	25104	Injection Check/Back Pressure Valve Asm			1
16	25201	Discharge Valve Assembly	1	1	
	25105	Discharge Valve Assembly			1
17	25202	Suction Valve Assembly	1	1	
	25107	Suction Valve Assembly			1
18	25204	Foot Valve Assembly	1	1	
	25109	Foot Valve Assembly			1
19	10521	Head Assembly, LE-71T, 1.8 Acrylic	1		
	25225	Head Assembly, LE-72T, 1.8 PVC		1	
	25110	Head Assembly, LE-75T			1
20	10141-06	Tubing, Vinyl, .5" O.D.	1		
26	27352	Flapper Valve	1	1	
27	10294	Injector Fitting, PVC	1		
	26841	Injector Fitting, PVDF		1	
	10394	Injector Fitting, P.P.			1
	32293	Suction Tubing Straightener (Not Shown)	1	1	1

* Parts included in Spare Parts Kit No. SP-U2.

NOTE:
Threaded connections into pump head are 3/4"-16 straight threads. **Do not use Teflon tape.** These joints are sealed by seal ring valve seats (item 4 on exploded view)



FOUR FUNCTION VALVES

INSTALLATION INSTRUCTIONS

The LMI four function valve is designed to replace the discharge valve on the LMI pump. Carefully remove the discharge valve currently on the pump and replace it with the four function valve.

VALVE MODELS

25690	**25700**	**25900**	**26035**	**26615**
27043	**27048**	**27051**	**28010**	**28022**
28046	**30419**	**30420**	**30475**	**30476**

A. PRIMING

1 Connect pressure release tubing to pressure release port.

2. Route tubing to solution reservoir and anchor with plastic tie provided.

3 Set pump at 80% speed and 100% stroke Start pump

4 Pull on Pressure Release knob (red or black knob) holding knob out until chemical is visible through translucent return tubing.

5. Pump is now primed.

NOTE
(a) Pump is normally self-priming if suction lift is no more than 5 ft. (1.5m), valves in the pump are wet with water (pump is shipped from factory with water in pump head) and the above steps (A1 thru A3) are followed

(b) If the pump does not self prime, remove Anti-Syphon/Pressure Release Valve Assembly and discharge valve ball, and pour water or chemical slowly into discharge port until it is filled. Replace valve ball and follow steps A1 thru A5 thereafter

B. DEPRESSURIZING DISCHARGE LINE

1. It is possible to depressurize discharge line and pump head without removal of tubing or loosening of fittings.

Be sure injection check valve is properly installed and is operating. If a gate valve or globe has been installed, downstream of injection check valve, it should be closed. Be certain relief tubing is connected and run to chemical reservoir.

2. Pull on both anti-syphon and relief knobs

3. The discharge line is now depressurized.

4 If injection check valve is of higher elevation than pump head, disconnecting tubing at injection check valve end will allow air to enter and cause chemical to drain back to tank.

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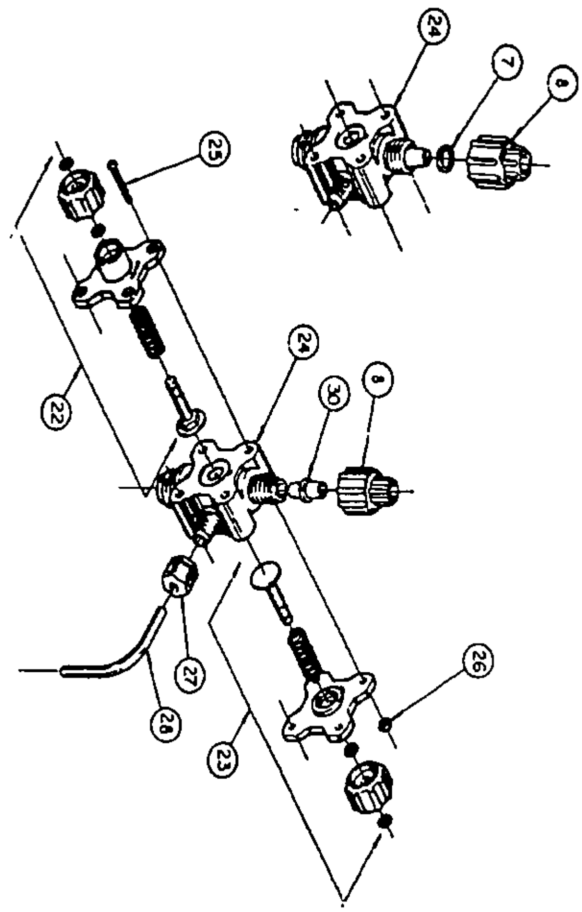
KEY NO.	PART NO.	DESCRIPTION	QUANTITY PER ASSEMBLY														
			25690	25700	25900	26035	26615	27043	27048	27051	28010	28046	28022	30419	30420	30475	30476
8	10299		1						1		1	1	1		1	1	1
	10211	Coupling nut		1				1						1			
	10411				1												
22	25691					1											
	25837						1				1						
	27044									1		1					
	28445		1	1													
	28446	Relief cap assembly			1								1				
	28447							1	1								
	30453													1	1		
	30460															1	
	30455																1
23	25838				1		1				1		1				
	27045	Anti-syphon cap						1	1	1		1					
	30452	assembly												1	1		
	30459															1	
	30454																1
	25692		1	1		1											
25	25627	Screw	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
24	25369		1												1		
	25500			1										1			
	25869												1				
	25870				1												
	25500-1					1											
	25870-1						1										
	26856	Valve Body						1									
	26856-1									1							
	26937																
	28703										1					1	
	28704											1					
26	25628	Nut	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
27	25631	Ferrule Nut	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
28	25636-10	Tubing, 25" O D	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	26136	Clamp Ring	1						1				1		1		1
30	28663	Ferrule									1	1				1	
	10156	Wire Tie (not shown)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	28898	Dowel (not shown)									1	1		1	1	1	1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Data Sheet Series C

Configuration Data

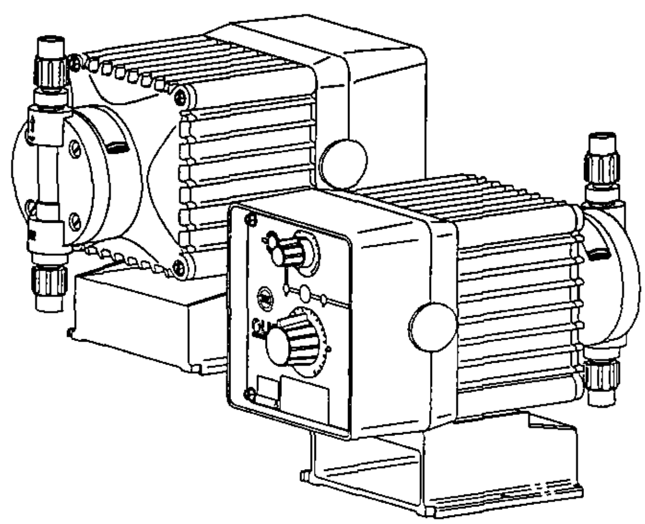
Model C92 1 - 363SI

Control & Output Code
Manual Control
Speed (stroking frequency) and stroke length manually adjustable.
C10 -- 1 3 GPH (4 9 l/h) . 300 psi (20 7 Bar)
C11 -- 2.5 GPH (9 5 l/h) .. 150 psi (10 3 Bar)
C12 -- 4 0 GPH (15 1 l/h) . 100 psi (6 9 Bar)
C13 -- 8 0 GPH (30 l/h) .... 60 psi (4 1 Bar)
C14 --- 20 GPH (76 l/h) 25 psi (1 7 Bar)
Instrument Responsive/Manual Control
Manual adjustment features of C1 Series plus switch conversion to external control for automatic systems
C70 -- 1 3 GPH (4 9 l/h) 300 psi (20 7 Bar)
C71 -- 2 5 GPH (9 5 l/h) . 150 psi (10 3 Bar)
C72 -- 4 0 GPH (15 1 l/h) 100 psi (6 9 Bar)
C73 -- 8 0 GPH (30 l/h) 60 psi (4 1 Bar)
C74 --- 20 GPH (76 l/h) 25 psi (1 7 Bar)
C77 --- 10 GPH (38 l/h) 80 psi (5 5 Bar)
C78 --- 25 GPH (95 l/h) 30 psi (2 07 Bar)
C90 -- 1 3 GPH (4 9 l/h) 300 psi (20 7 Bar)
C91 -- 2 5 GPH (9 5 l/h) 150 psi (10 3 Bar)
C92 -- 4 0 GPH (15 1 l/h) 100 psi (6 9 Bar)
C93 -- 8 0 GPH (30 l/h) 60 psi (4 1 Bar)
C94 --- 20 GPH (76 l/h) 25 psi (1 7 Bar)

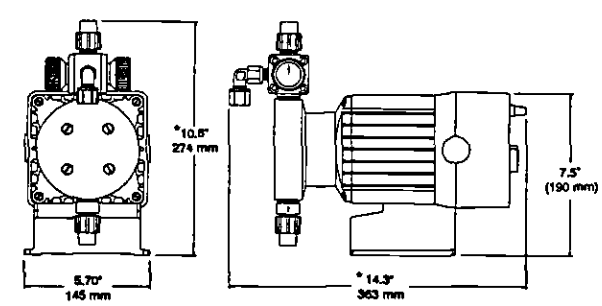
Voltage Code
1 -------120 VAC US Plug
2 -------240 VAC US Plug
3 -------220-240 VAC DIN Plug
5 -------240-250 VAC, UK Plug
6 -------240-250 VAC, AUST/NZ Plug
7 -------220-240 VAC, SWISS Plug

Liquid End
See next page for complete liquid end specifications and selection

Electronic Metering Pumps

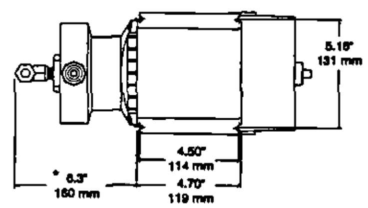


Dimensions



* Dimensions shown are maximums for largest available Liquid End

Dimensions will vary depending on Liquid End selected



Specifications

Series	Strokes Per Minute (Adjustable) Min	Max	Stroke Length (Adjustable) Recommended Minimum	Average Input Power @ Max Speed	Shipping Weight
C10, C70, C90 C11, C71, C91 C12, C72, C92 C13, C73, C93 C14, C74, C94	1	100	10%	44 watts	20 lbs (9 1 kg)
C77 C78	1	100	10%	87 watts	28 lbs (12 7 kg)

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MILTON ROY
A unit of Sundstrand Corporation

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FAX: (978) 264-9172
http://www.lmipumps.com

Replaces same of Rev B 5/96
1712.C 9/97

685 197

Configuration Data & Materials of Construction

Drive Assembly	Liquid End No.	Size Code	Materials of Construction: Head & Fittings	Balls	Liquifram™	Seal Ring	Accessory	Tubing & Connections: Discharge	Suction
C90☐-									
C70☐-	297	0 9	316 S S	316 S S	Fluorofilm™	316 S S		Pipe 1/4" NPT M	
C10☐-	94S**	0 9	PVC	Ceramic	Fluorofilm™	PTFE	4FV	Pipe 1/4" NPT M	
	360SI†	1 8	Acrylic/PGC	Ceramic	Fluorofilm™	PGC / Polyprel®	4FV	PE 375" O D	
	361SI†	1 8	PGC/PGC	Ceramic	Fluorofilm™	PGC / Polyprel®	4FV	PE 375" O D	
C91☐-	362SI†	1 8	PVDF / PVDF	Ceramic	Fluorofilm™	PVDF/ Polyprel®	4FV	PE 375" O D	
C92☐-	363SI†	1 8	PVDF / PVDF	Ceramic	Fluorofilm™	PVDF/ PTFE	4FV	PE 375" O D	
C71☐-	277	1 8	316 S S	316 S S	Fluorofilm™	316 S S		Pipe 1/4" NPT M	
C72☐-	71FS	1 8	Acrylic/PVDF	PTFE	Hypalon®	Hypalon®	4FV	PE 5" O D	Vinyl 5" O D
C11☐-	71S†	1 8	Acrylic/PVC	Ceramic	Fluorofilm™	PTFE	4FV	PE 5" O D	Vinyl 5" O D
C12☐-	72S†	1 8	PVC	Ceramic	Fluorofilm™	PTFE	4FV	PE 5" O D	
	74S**	1 8	PVC	Ceramic	Fluorofilm™	PTFE	4FV	Pipe 1/4" NPT M	
	75HV	1 8	Polypropylene	316 S S	Fluorofilm™	PTFE		PE 5" O D	Vinyl 938" O D
	75S†	1 8	Polypropylene	Ceramic	Fluorofilm™	PTFE	4FV	PE 5" O D	
	76	1 8	Acrylic/PP	316 S S	Fluorofilm™	Hypalon®		PE 5" O D	Vinyl 938" O D
	79	1 8	UHMW PE	Ceramic	Hypalon®	Hypalon®		PE 5" O D	Vinyl 5" O D
	310SI†	3 0	Acrylic/PGC	Ceramic	Fluorofilm™	PGC / Polyprel®	4FV	PE 375" O D	
	311SI†	3 0	PGC/PGC	Ceramic	Fluorofilm™	PGC / Polyprel®	4FV	PE 375" O D	
	312SI†	3 0	PVDF / PVDF	Ceramic	Fluorofilm™	PVDF/ Polyprel®	4FV	PE 375" O D	
C93☐-	313SI†	3 0	PVDF / PVDF	Ceramic	Fluorofilm™	PVDF / PTFE	4FV	PE 375" O D	
C73☐-	20HV	3 0	Acrylic/PP	316 S S	Fluorofilm™	Hypalon®		PE 5" O D	Vinyl 938" O D
C13☐-	20S**	3 0	Acrylic/PVC	Ceramic	Fluorofilm™	Hypalon®	4FV	PE 5" O D	Vinyl 5" O D
	24	3 0	PVC	Ceramic	Fluorofilm™	PTFE		Pipe 1/2" NPT M	
	25HV	3 0	Polypropylene	316 S S	Fluorofilm™	PTFE		PE 5" O D	Vinyl 938" O D
	25P	3 0	Polypropylene	Ceramic	Fluorofilm™	PTFE		Pipe 1/2" NPT M	
	25T	3 0	Polypropylene	Ceramic	Fluorofilm™	PTFE		PE 5" O D	
	26S**	3 0	PVC	Ceramic	Fluorofilm™	Viton®	4FV	PE 5" O D	
	27	3 0	316 S S	316 S S	Fluorofilm™	PTFE		Pipe 1/2" NPT M	
	29	3 0	UHMW PE	Ceramic	Fluorofilm™	Hypalon®		PE 5" O D	
	30	6 0	Acrylic/PVC	Ceramic	Fluorofilm™	PTFE		PE 5" O D	Vinyl 5" O D
C94☐-	32	6 0	PVDF	Ceramic	Fluorofilm™	PTFE		PE 5" O D	
C78☐-	34	6 0	PVC	Ceramic	Fluorofilm™	PTFE		Pipe 1/2" NPT M	
C74☐-	35P	6 0	Polypropylene	Ceramic	Fluorofilm™	PTFE		Pipe 1/2" NPT M	
C14☐-	35T	6 0	Polypropylene	Ceramic	Fluorofilm™	PTFE		PE 5" O D	
	36	6 0	PVC	Ceramic	Fluorofilm™	PTFE		PE 5" O D	
	37	6 0	316 S S	316 S S	Fluorofilm™	PTFE		Pipe 1/2" NPT M	
	20HV	3 0	Acrylic/PP	316 S S	Fluorofilm™	Hypalon®		PE 5" O D	Vinyl 938" O D
	20S**	3 0	Acrylic/PVC	Ceramic	Fluorofilm™	Hypalon®	4FV	PE 5" O D	Vinyl 5" O D
	24	3 0	PVC	Ceramic	Fluorofilm™	PTFE		Pipe 1/2" NPT M	
C77☐-	25HV	3 0	Polypropylene	316 S S	Fluorofilm™	PTFE		PE 5" O D	Vinyl 938" O D
	25P	3 0	Polypropylene	Ceramic	Fluorofilm™	PTFE		Pipe 1/2" NPT M	
	25T	3 0	Polypropylene	Ceramic	Fluorofilm™	PTFE		PE 5" O D	
	26S**	3 0	PVC	Ceramic	Fluorofilm™	Viton®	4FV	PE 5" O D	
	27	3 0	316 S S	316 S S	Fluorofilm™	PTFE		Pipe 1/2" NPT M	
	29	3 0	UHMW PE	Ceramic	Fluorofilm™	Hypalon®		PE 5" O D	

☐ See front page for voltage code specifications

** *These Liquid Ends are available without a 4FV, simply drop the 'S' at the end of the Liquid End number to order the model without a 4FV*

† To specify ¼" NPT male, change 'I' to 'P' To specify black, UV resistant tubing, change 'I' to 'U' To specify Bleed 4FV, change 'S' to 'B' To *specify 3FV, change 'S' to 'T'*

Fluorofilm™ is a copolymer of PTFE and PFA

Polyprel® is an elastomeric PTFE copolymer

4FV indicates that the pump is equipped with an LMI Four Function Valve This diaphragm type anti-syhon/pressure relief valve is installed on the pump head It provides anti-syphon protection and aids in priming, even under pressure

Output Information

Series	Gallons per Hour Min*	Max	Liters per Hour Min*	Max	mL/cc per Minute Min*	Max	mL/cc per Stroke Min*	Max	Maximum Injection Pressure	
C10, C70*, C90*	0 001	1 3	0 005	4 9	0 08	82	0 08	0 82	300 psi	(20 7 Bar)
C11, C71*, C91*	0 003	2 5	0 010	9 5	0 16	158	0 16	1 58	150 psi	(10 3 Bar)
C12, C72*, C92*	0 004	4 0	0 015	15 1	0 25	252	0 25	2 52	100 psi	(6 9 Bar)
C13, C73*, C93*	0 008	8 0	0 030	30	0 51	505	0 51	5 05	60 psi	(4 1 Bar)
C14, C74*, C94*	0 020	20 0	0 076	76	1 26	1262	1 26	12 62	25 psi	(1 7 Bar)
C77*	0 010	10 0	0 038	38	0 63	631	0 63	6 31	80 psi	(5 5 Bar)
C78*	0 025	25 0	0 095	95	1 58	1577	1 58	15 77	30 psi	(2 07 Bar)

* *Minimum output is based on 1 stroke per minute and 10% stroke setting, minimum output can be reduced further in external modeSeries C9 pumps may be programmed for strokes per hour for lower outputs*

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Specification Sheet
Series C

GENERAL

Chemical metering pumps shall be positive displacement, Liquifram™ type pumps. Output volume shall be adjustable while pumps are in operation from zero to maximum capacity of:

C10,C70,C90	—1.3GPH	(4.9 liters/hour)
C11,C71,C91	—2.5GPH	(9.5 liters/hour)
C12,C72,C92	—4.0GPH	(15.1 liters/hour)
C13,C73,C93	—8 0GPH	(30.0 liters/hour)
C14,C74,C94	—20.0GPH	(76.0 liters/hour)
C77	—10.0GPH	(38.0 liters/hour)
C78	—25.0GPH	(95.0 liters/hour)

Chemical metering pumps shall be capable, without a hydraulically backed diaphragm, of injecting chemicals against pressures up to.

C10,C70,C90	— 300 psig	(20 7Bar)
C11,C71,C91	— 150 psig	(10.3Bar)
C12,C72,C92	— 100 psig	(6 9Bar)
C13,C73,C93	— 60 psig	(4 1 Bar)
C14,C74,C94	— 25 psig	(1 7Bar)
C77	— 80 psig	(5 5Bar)
C78	— 30 psig	(2 07Bar)

SERIES C1

Adjustment shall be by readily accessible dial knobs, one for changing stroke length and the other for changing stroke frequency (speed). Both knobs are to be located opposite the liquid handling end

SERIES C7

Control of Series C7 metering pumps shall be selectable between internal and external pulsing by means of a 3-position center-off switch. Stroke length shall be adjustable by means of readily accessible dial knob. When in external pulsed mode, Series C7 units shall accept signals without the use of electrical timer or internal timer. Pressure capacity shall be adjustable to reduce noise, vibration and wear.

SERIES C9

Series C9 metering pumps shall have a clear liquid crystal display. Controlshall be selectable between internal and external pulsing by means of a tactile keypad. Internal stroke frequency shall be adjustable from 1 stroke per hour to 100 strokes per minute Pressure capacity shall be keypad adjustable to reduce noise, vibration and wear. Metering pump shall be capable of dividing or multiplying pulse inputs from 1 to 999 or responding directly or inversely to a 4 - 20mA input signal

DRIVE

The pump drive shall be totally enclosed with no exposed moving parts Solid state electronic pulser shall beencapsulated and supplied with quick connect terminals at least 3/16" (4.75 mm) wide. Electronics shall be housed in chemical resistant enclosure at the rear of the pump for maximum protection against chemical spillage. Electrical power consumption shall not exceed 87 watts under full speed and maximum pressure conditions. Pump weight shall not exceed 28 lbs (12.7 kg).

AUTOMATIC PRESSURE RELIEF

To eliminate need for pressure relief valve, Liquifram™ shall automatically stop pulsating when discharge pressure exceeds pump pressure rating by not more than 35%.

MATERIAL

Chemical metering pump housing shall be of chemically resistant glass fiber reinforced thermoplastic with a glass fiber reinforced polypropylene EPU carrier[6]. All exposed fasteners shall be stainless steel. Chemical metering pump valves shall be ball type, with ceramic balls[1]. Valve seat and seal ring shall be renewable by replacing the combination seat-seal ring [2] or cartridge valve assembly Pump head shall be of transparent acrylic [3] material capable of resisting the pumped chemical. Fittings and connections at pump head shall be PVC[4].

CHECK VALVE AND TUBING

A total of 16 ft (4.8 m) of polyethylene tubing [5] shall be provided per pump complete with compressing connections A foot valve with integral one piece strainer shall be provided for the suction line, and an injection check/back pressure valve with ½" NPT male connection for the injection point. The injection check valve shall incorporate a dilating orifice which inhibits accumulation of crystalline deposits.

NOTES:

1. Type 316 stainless steel or PTFE may be specified.
2. Hypalon®,Polyprel®, Viton® or PTFE may be specified.
3. PVC, polypropylene, or Type 316 stainless steel may be specified.
4. PVDF, polypropylene, or Type 316 stainless steel may be specified.
5. 6 ft (1.8 m) of vinyl suction tubing may be specified in place of polyethylene for the suction side only. ¼" or ½" male pipe thread may be specified.
6. With plastic coated cast iron EPU carrier for Series C77 and C78.

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MILTON ROY
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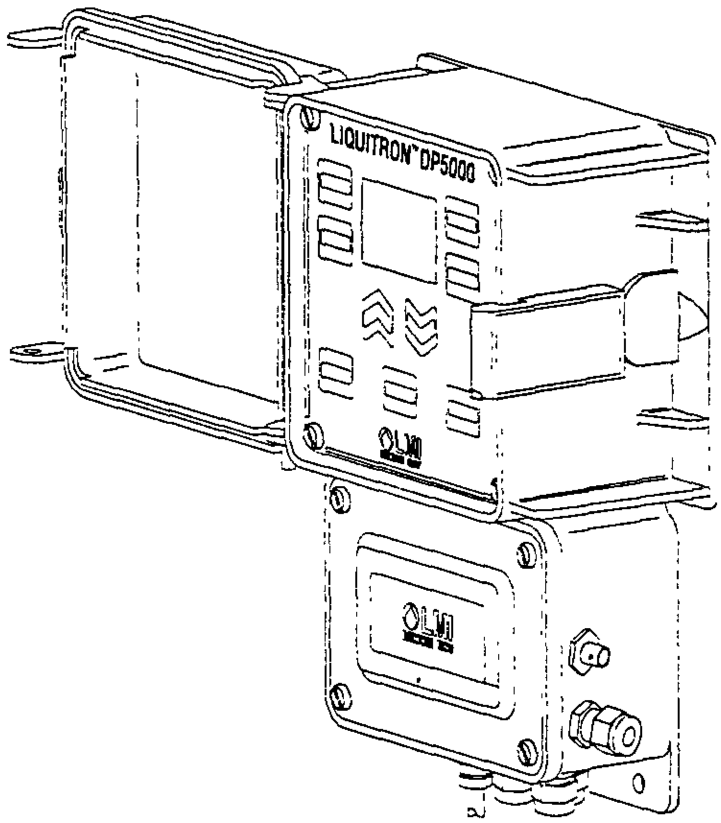
685 199

Instruction **Manual**

Liquitron™ Series DP5000 pH Controller



For file reference, please record the following data:

Model No: ____________________

Serial No: ____________________

Installation Date: ____________________

Installation Location: ____________________

When ordering replacement parts for your LMI Controller or accessory, please include the complete Model Number and Serial Number of your unit.

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Cont nts

685 201

1.0 Introduction

The Liquitron™ DP5000 Series pH Controllers are designed for a variety of industrial pH applications including metal finishing, water treatment, printed circuit board manufacturing and waste treatment.

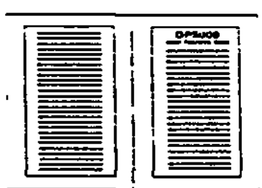
The DP5000 is a microprocessor-based pH controller with a backlit customized display and tactile keypad for ease of programming. The DP5000 allows independent programming of control methods ('ON/OFF' or 'PROPORTIONAL') for acid (Pump A) or base (Pump B) dosage. Independent high and low pH alarms may be set with activation of the 'Alarm relays.' A third relay output is available for activating a solenoid valve or other devices.

The controller is compatible with any pH electrode that generates a mV signal and allows incorporation of platinum 1000 Ω automatic temperature compensation (ATC) elements. Two point or single point pH calibrations may be performed. Timer functions for pump 'Run' time and solenoid 'Delay' times can be programmed to operate a solenoid pump valve. An 'Advanced Menu' allows selection of special features such as a 'Point 3' (inflection point) for the control profiles of the acid or alkali pumps for finer control. The DP5000 features continuous non-volatile memory back-up, voltage selection. pre-amplifier outputs, flow and level switch inputs as standard. 4-20 mA recorder output is optional.

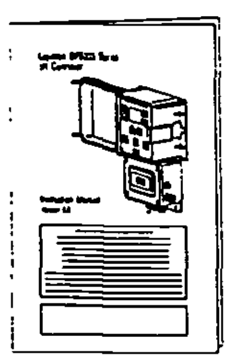
2.0 Unpacking

Your carton will contain the items shown in Figure 1. Please notify the carrier immediately if there are any signs of damage to the controller or its parts. Contact your LMI Distributor if any of the parts are missing.

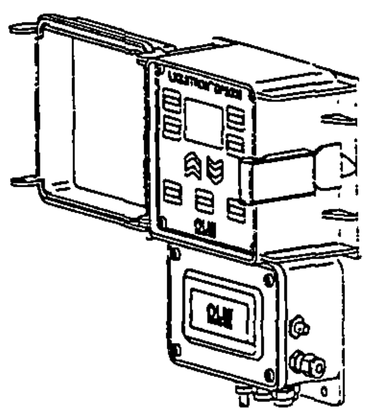
There is a number label on the inside cover of the unit; for easy reference, you should note the model and serial numbers on the front cover of this instruction manual.



Quick Reference Guide



User Manual



DP5000 pH Controller

Figure 1: Unpacking Items

3.0 Installation

Pre-Installation

Be sure that the unit has a plug and voltage code compatible with the power source that you intend to use

Environment

The housing is corrosion and spray resistant but should not be subjected to excessive spray or ambient temperature over 122° F (50° C). Never immerse the unit.

Installation

The DP5000 Controller should be mounted on a solid, stable surface. pH adjustment pumps should be installed following the manufacturer's recommendations. For installations requiring longer cables, consult your distributor. The electrode installation will vary, depending on the process used. In general, the temperature electrode and pH electrode should be mounted together, and placed far enough downstream from the source of pH adjusting solution that sufficient mixing may occur, but close enough to eliminate hydraulic lag time of response. Refer to the typical installation diagrams on the following page

3.1 Mounting the Electronic Enclosure

The DP5000 control module is supplied with integral wall mounting flanges. It should be hung with the display at eye level, on a vibration-free structure, in a location where liquids will not be splashed on it. All four (4) top-mounting holes should be used for structural stability. The control module requires the following clearances

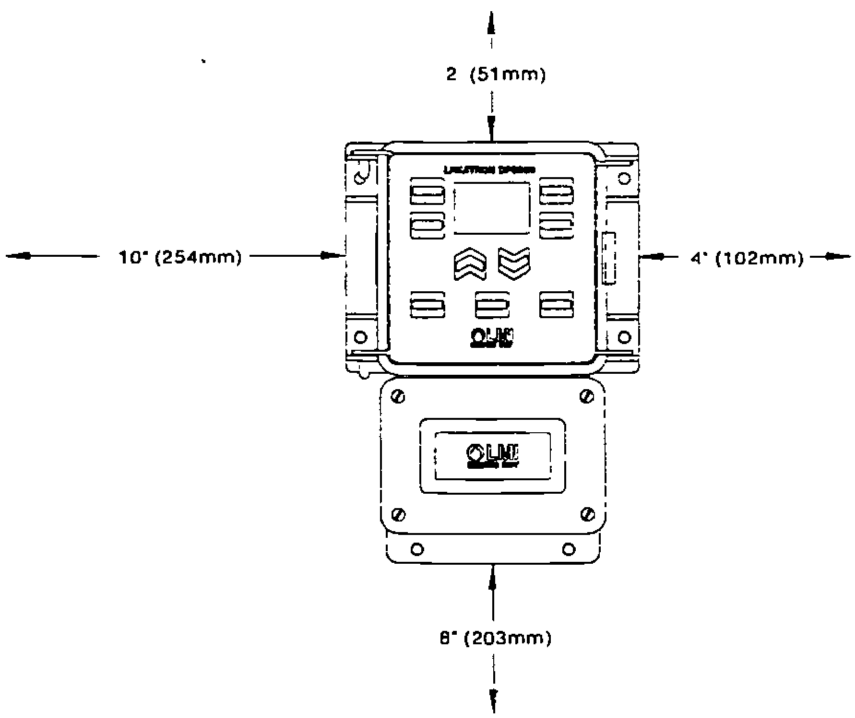


Figure 2: Minimum Clearances

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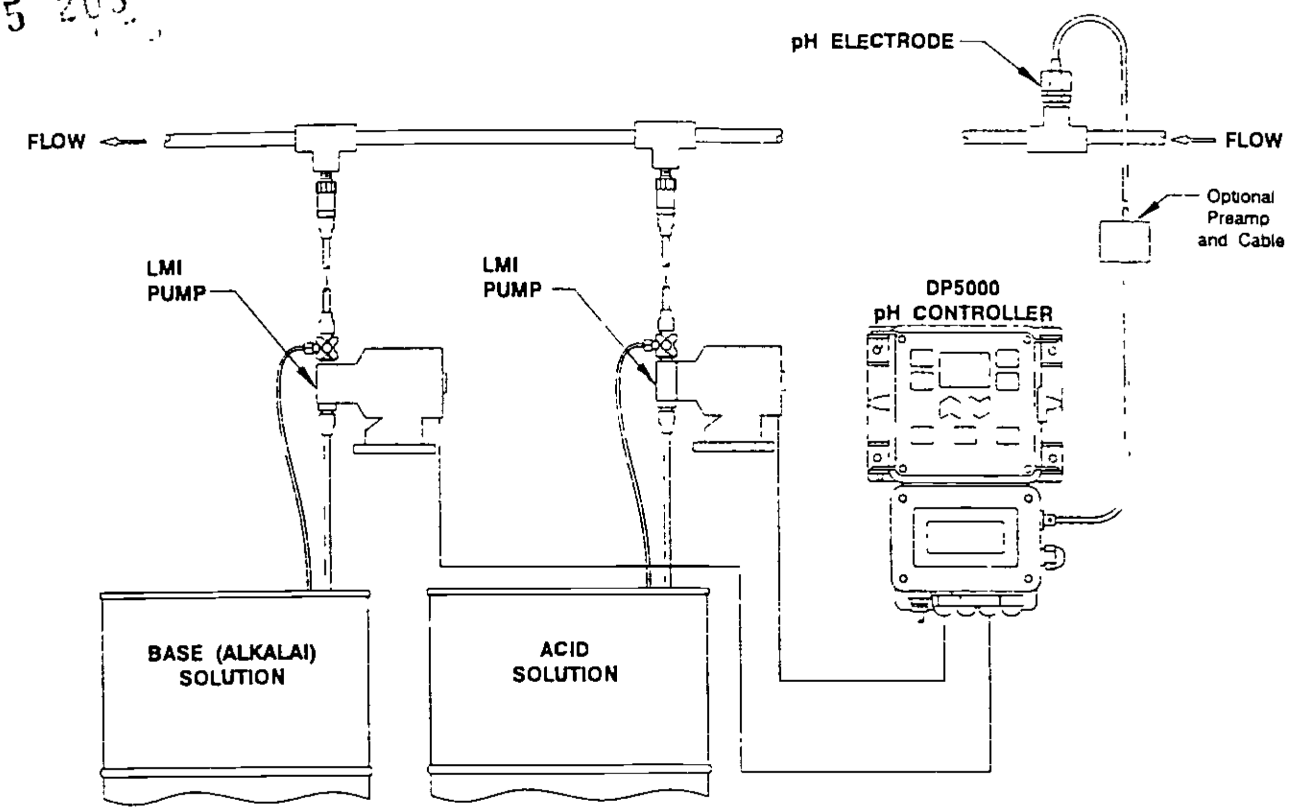


Figure 3A: Typical In-Line Installation

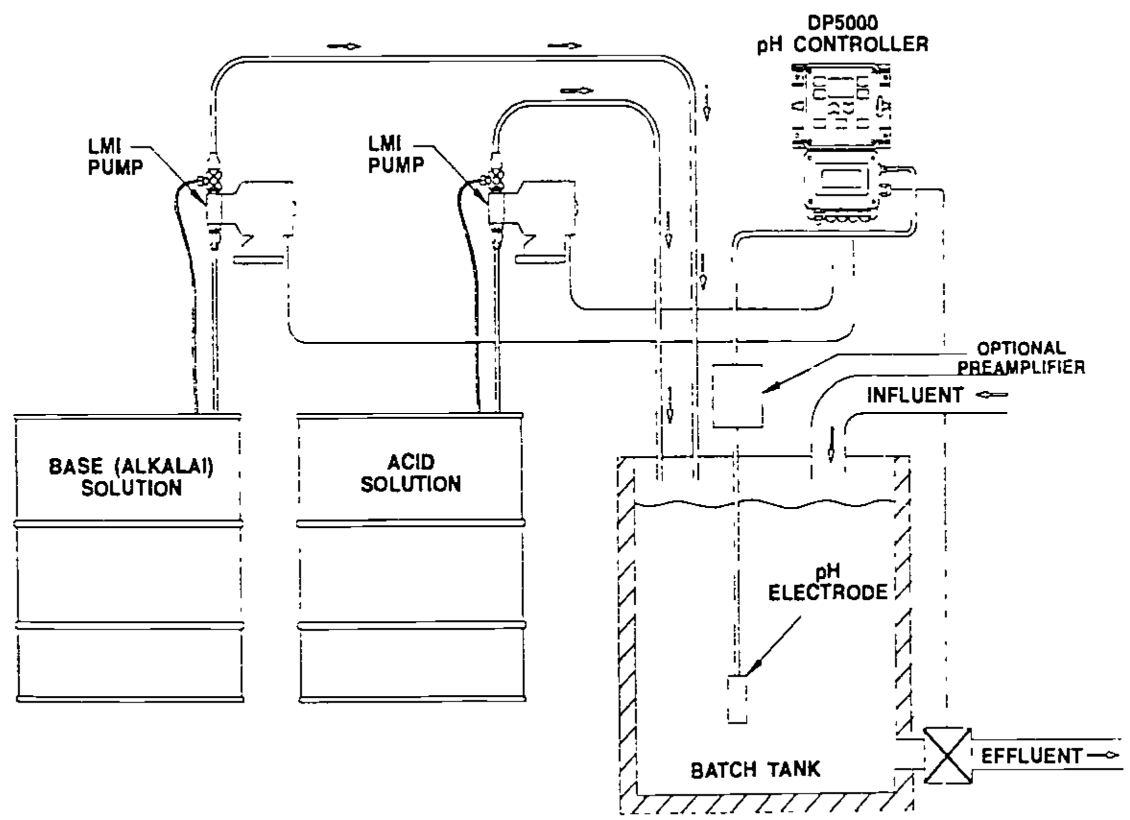


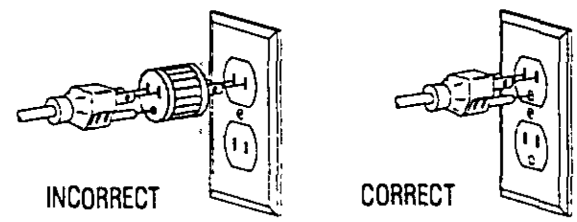
Figure 3B: Typical Batch Installation

3.2 Electrical Installation

685 204

Electrical Connections

To reduce the risk of electrical shock, the control or metering pump must be plugged into a ground outlet with ratings conforming to the data on the control panel It must be connected to a good ground DO NOT USE ADAPTERS! All wiring must conform to local electrical codes



Electrical installation of the DP5000 Series pH Controllers consists of plugging the control module into a proper line outlet. Based on model number, the following voltages and receptacles are required:

DP5000-1A **DP5000-1B,** 115 V, 60 Hz USA Cord	**DP5000-3A** **DP5000-3B** 230 V, 50 Hz, DIN Cord	**DP5000-6A** **DP5000-6B** 230 V, 50 Hz AUS/NZ Cord	**DP5000-01A** **DP5000-01B** 115 V, 60 Hz No Cord
DP5000-2A **DP5000-2B** 230 V, 60Hz USA Cord	**DP5000-5A** **DP5000-5B** 230 V, 50 Hz UK Cord	**DP5000-7A** **DP5000-7B** 230 V, 50Hz SWISS Cord	**DP5000-02A** **DP5000-02B** 230 V, 50/60Hz No Cord

Connect the pH adjustment pump(s) to the terminal strip for 'ON/OFF' control (connect to receptacles directly for 115 V models) or to cables for 'PROPORTIONAL' control. Connect the pH electrode to the BNC connector on the right side of the control module. Take care not to twist or strain the wires. If equipped, connect the ATC cable (1000 Ω at 32° F [0° C]) through the cable gland below the BNC connector to the terminal strip. You may optionally connect an alarm, solenoid, flow switch and low level switch. You may also connect the mA or communications connections (with the option fitted) The ± 5 V supply for electrode pre-amplification is also accessed on the terminal strip. There is a 500 Ω maximum resistance for 4-20 mA option (refer to Figures 4 and 5)

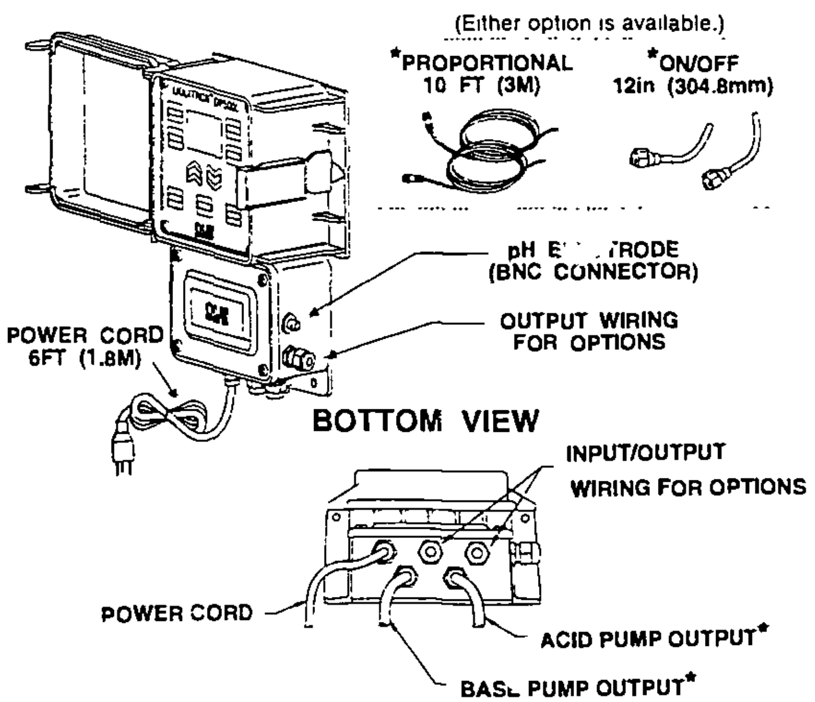


Figure 4: Electrode and Pump Connections

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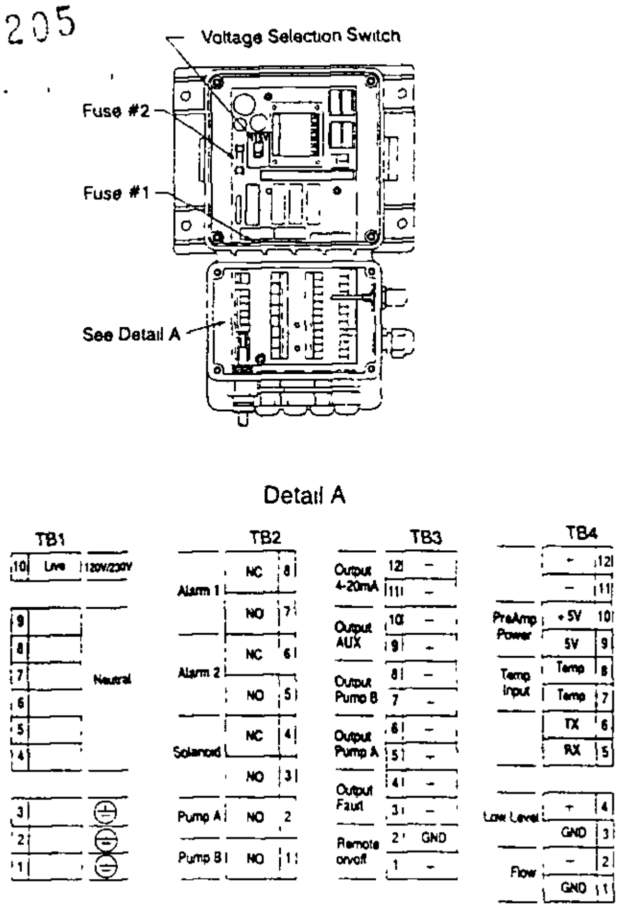


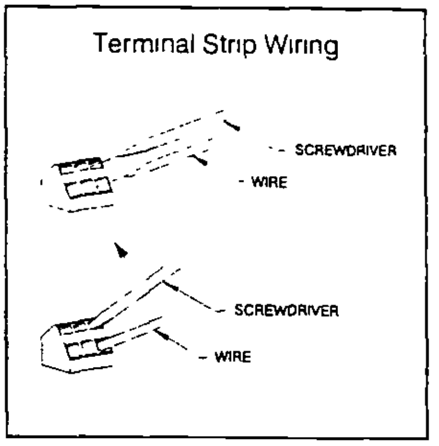


Figure 5: Terminal Strip

3.2.1 Terminal Board Signal Description

Terminal blocks are TB1-TB4 from left to right, and Pin 1 is at the bottom of each terminal block

TB1 Terminal Strip

TB1 Pin 1-Pin 3 .... Earth connection (one for input power connection)
TB1 Pin 4-Pin 9 .. . .. Neutral power connection (one for input power connection)
TB1 Pin 10 .. .. AC Mains live input

TB2 Terminal Strip

TB2 Pin 1 .... Form A contact closed when Pump B (base) is ON
TB2 Pin 2 .... Form A contact closed when Pump A (acid) is ON
TB2 Pin 3-4 .... Form C contact activated, (if programmed) when pH is within programmed limits (solenoid pump)
TB2 Pin 5-6 .... Form C contact activated when Alarm Setpoint 2 exceeded (powered output contacts)
TB2 Pin 7-8 .... Form C contact activated when Alarm Setpoint 1 exceeded (powered output contacts)

TB3 Terminal Strip

TB3 Pin 1-2. .. .. Opto isolated input - low or short stops pumps (OFF on display)(Remote ON/OFF)
TB3 Pin 3-4 .... Opto isolated output - low when alarm condition exists
TB3 Pin 5-6 ... . Opto isolated output - pulse train to drive Pump A
TB3 Pin 7-8 .... Opto isolated output - pulse train to drive Pump B
TB3 Pin 9-10 .... Spare, not programmed
TB3 Pin 11-12 .... 4-20 mA output proportional to pH (programmable limits) (optional) (polarity sensitive)

TB4 Terminal Strip

TB4 Pin 1-2. .... Opto isolated input - flow switch input (add jumper if no flow switch is used)
TB4 Pin 3-4 .... Opto isolated input - flow switch input (add jumper if no level switch is used)
TB4 Pin 5-6 .. .. Serial communications lines (optional)
TB4 Pin 7-8 .... Temperature input (from platinum Ω probe)
TB4 Pin 9-10 . .. . Power voltage source for preamp
TB4 Pin 11-12. .. .. Spare, not programmed

3.2.2 Field Wiring Instructions

Typical US field installation would find a 6 ft (2 m) AC cord wired and two (2) 1 ft (30 cm) AC receptacles ('ON/OFF' mode) or two (2) 10 ft (3 m) pump drive cables ('PROPORTIONAL' mode) installed. A BNC receptacle would be installed for the pH probe.

Connect the two (2) pumps appropriately. Install the probe, run the cable back to the controller and attach to BNC receptacle. If the probe is farther than 25 ft (7.6 m) from the controller, a preamp may be desirable to reduce noise effects If this is the case, run +5 V/-5 V as required by your preamp. Current draw must not be greater than 10 mA.

If a flow meter and/or low-level tank switch is available, run wires to the controller - entering through one of the spare cable ports. Remove the appropriate jumper(s) and attach the external wires. Polarity does not matter Wire size #20-22 is adequate.

Alarm relays 1 and 2 are provided to signal an out of tolerance condition externally. These are Form C contacts, providing a common, a normally open and a normally closed connection.These terminals provide power output.

A solenoid drive relay (Form C contacts, providing a common, a normally open and a normally closed connection) is provided that can be connected to drain a tank when the pH is within programmed limits. A delay can be programmed after initially entering this programmed zone, to allow conditions to settle within the tank. The duration of solenoid ON time is separately programmable. Wire size #16-18 is adequate. These terminals provide output power (main voltage)

The optional 4-20 mA PCB provides a fully programmable 4-20 mA output based on the pH readings The optional PCB plugs into the back of the computer pc board, as shown in Figure 6.

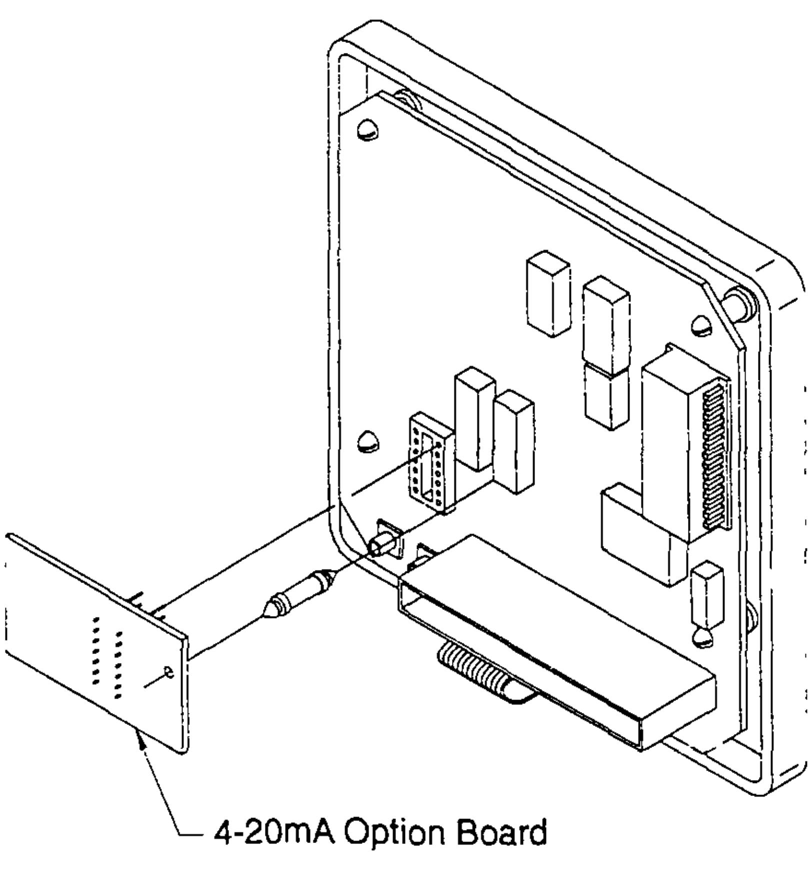


Figure 6: Circuit Board

685 207

3.3 pH Adjustment Pump(s)

There are two (2) versions of the DP5000, one is the 'ON/OFF' Output and the second is 'PROPORTIONAL' Output

The **On/Off Output** DP5000 pH Controller will operate any pH adjustment pump(s) which operate on the same line voltage as the controller itself Combined continuous controlled load must not exceed 6A @ 115 V or 3A @ 230 V To ensure efficient control, the pumps should be capable of delivering at least 150% of the maximum pumping requirement Install and calibrate the pumps according to the manufacturer's recommendations

The **Proportional Output** DP5000 pH Controller will operate any LMI A9, A7, B9, B7, C9, C7, E7 or L7 pump, or any other pump which operates by providing direct proportional response to a modulated pulse input signal. The pumps must be set to the 'external' control mode To ensure efficient control, the pumps should be capable of delivering at least 150% of the maximum pumping requirement Install and calibrate the pumps according to the manufacturer's recommendations.

3.4 Keypad and Display

The DP5000 pH Controller menu allows the user to input all the variables necessary to customize the controller for the application The keypad is used for all programming (see Figure 7).

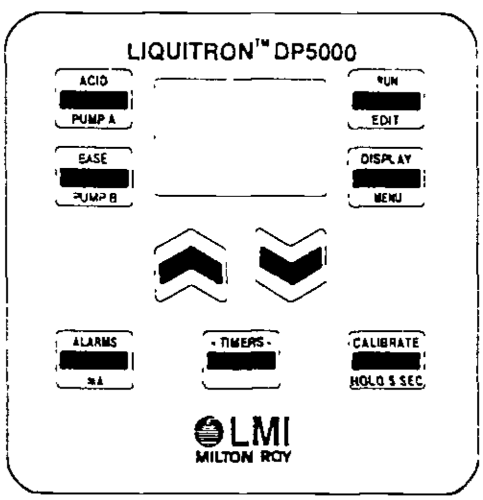
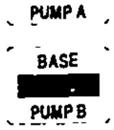


Figure 7: Keypad

Keys:

This key is used to set up the control profile for the acid dosing pump. (Holding the key for five (5) seconds will allow priming of Pump A) (Factory setting 90 SPM).



This key is used to set up the control profile for the base (alkali) dosing pump (Holding key for five (5) seconds will allow priming of Pump B) (Factory setting 65 SPM)

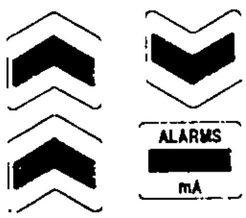
This key is used to program the high and low alarm points and hysteresis (ON/OFF mode) It also allows programming of the mA output when installed.

This key is used to program 'run times' for Pumps A and B, 'delay times' 1 and 2 for actuating and controlling a solenoid valve (when programmed 'ON' in the advanced features menu) This key also allows setting of the 'manual temperature' and the controller response rate Δ pH. If pump run time is over 11 10 hours, the run time is disabled The pump will not be stopped and will run continuously

This key when pressed will display details of the last successful electrode calibration (Holding this key for five (5) seconds will allow entry into a new calibration procedure [single or two point]).

Pressing this key will cause the display to alternate showing various settings. (Holding the key for five (5) seconds will allow entry to the 'advanced features' menu).

This key is used for starting and stopping (run or edit) the pumps and changing set points in the controller. It changes the mode of the controller from 'RUN' to 'OFF'



These keys are used to change values on the display.

Simultaneously pressing these two (2) keys will lock the keypad to prevent casual tampering Pressing them a second time will unlock the keypad (Wait five (5) seconds between locking and unlocking).

4.0 OPERATION

4.1 Default Settings

In the default mode, as shipped from the factory without any extended features programmed in the 'menu'. the controller is set to operate two (2) dosing pumps towards a single desired pH region as defined by the set points It will do this in one of two ways, 'ON/OFF' or 'PROPORTIONAL,' shown graphically below

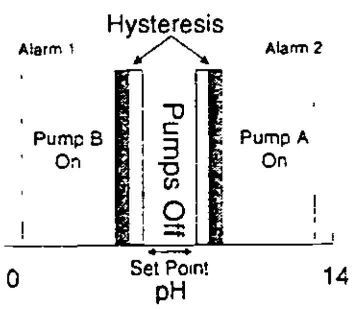


Figure 8: ON/OFF Control

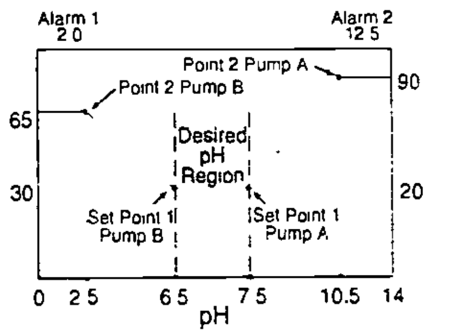
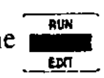
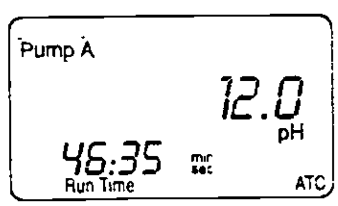


Figure 9: Proportional

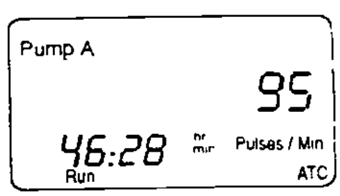
When the unit is plugged in, the computer powers up and the display illuminates The display flashes the pH reading and 'OFF'. This indicates the pumps will not operate and the unit is in the 'OFF' mode. When the  key is pressed the controller starts and switches into the 'RUN' mode

Example: (Proportional Controller)

This display shows a pH value of 12 0 Pump A is flashing indicating that the acid pump is in operation. The pump will stop pumping after 46:35 minutes if set point is not reached

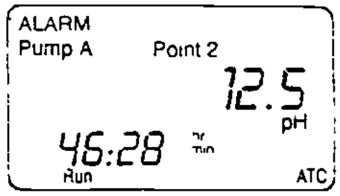


For two (2) seconds in every eight (8) seconds the display shows pump speed in pulses/minute The pulses/minute displayed relates to the pump that is in operation



685

When the pH value exceeds the programmed pH alarm point (12.5), the 'ALARM' flashes and the alarm relay is activated.



Note *Throughout this manual, the term 'pulse' is used to describe the mechanical stroke of the pump, as strokes per minute (SPM).*

4.1.1 Proportional Mode

The unit is shipped preset at the factory for the 'PROPORTIONAL' or 'ON/OFF' mode To change the unit to the opposite mode see 'Advanced Menu List,' Option 2, on page 20

Note *Controller must be in OFF' mode to program changes.*

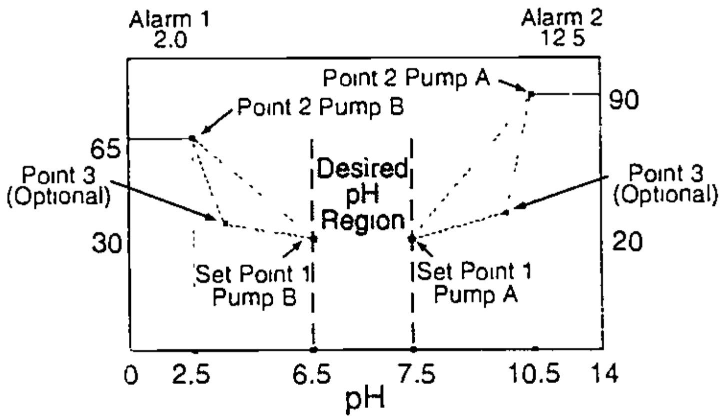
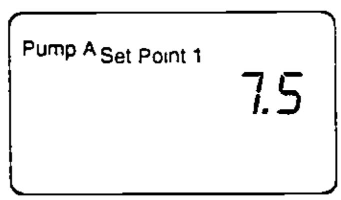


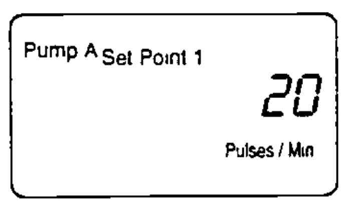
Figure 10: Pump A Control Profile

Pressing RUN/EDIT switches the mode back and forth from 'RUN' to 'OFF'. The pH set points and pump speed (pulses/min) can be changed only in the 'OFF' mode.



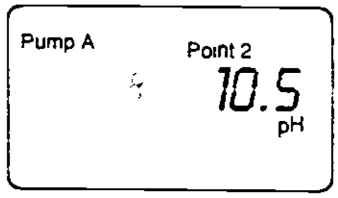
(1) ..... Press ACID/PUMP A

(2) ...... Press or to the increase/decrease the pH value of Set Point 1 for turning on 'Pump A'



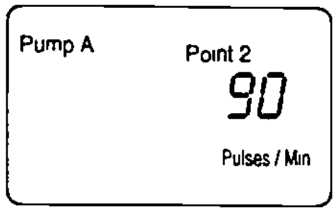
(3) ...... Press ACID/PUMP A again. This saves 'Pump A' Set Point 1 and then brings up Set Point 2 for 'Pump A'

(4) ..... Press or to increase/decrease the pH for Set Point 2.



(5) ......Press ACID PUMP A again

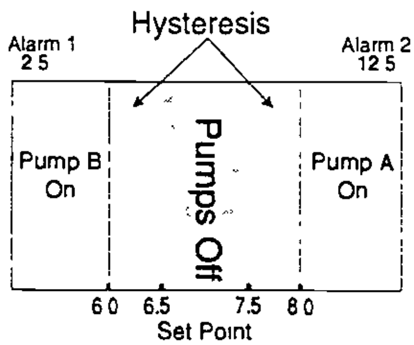
(6) ......Press or to increase/decrease pump speed (pulse/min) for Set Point 2.



'Pump B' (Base Pump) is programmed in a similar way.

Note *If 'Point 3' is selected in the Advanced Features Menu, the user will be prompted to enter a pH value for Set Point 3 and a Pump Speed at Set Point 3.*

4.1.2 On / Off Mode



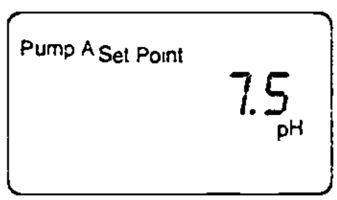
Pump A Control Profile

Note *Controller must be in 'OFF' mode to program changes*

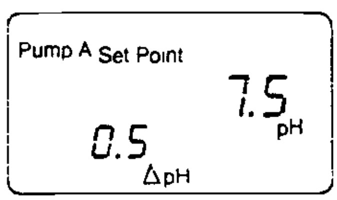
For 'ON/OFF' controllers with relay outputs (instead of pulse outputs) each pump is programmed as follows:

(1) ......Press ACID PUMP A ..this will display Set Point.

(2) ......Press or to increase/decrease pH Set Point.



(3) ......Press ACID PUMP A to save programmed Set Point.

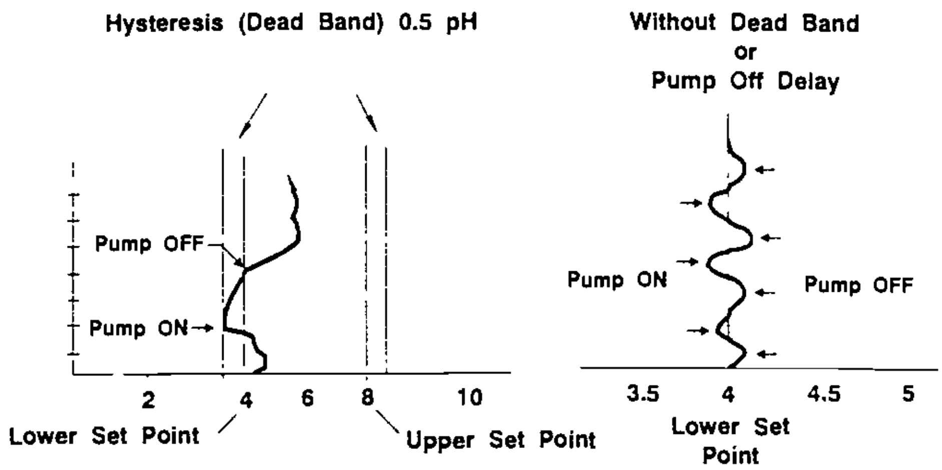


(4) ......Press or to program D pH (Hysteresis) period for relay In this example, 'Pump A' will turn on at a pH of 8 0 (set point + D pH) 'Pump A' will turn off when pH drops to 7 5.

'Pump B' (Base Pump) is programmed in a similar way

685 211

In this example, 'Pump B' will turn on at a pH of 3.5 (set point - Δ pH) and will turn off when pH reaches 4 0



It is highly recommended that the hysteresis (pump off function) be used to prevent relay chatter.

The function of the hysteresis is to prevent pump relay chattering. It operates by allowing the pump to be turned on when the control point plus (or minus) the hysteresis value has been met, but does not allow the pump to turn off until the control point has been met The chosen value will be used for both upper and lower set points.

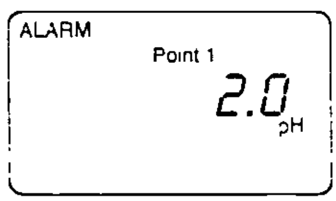
The hysteresis, or dead band, designates how many pH units beyond set point the pump runs before turning off Any value from 0 to 14 00 is acceptable. If use of this function is undesirable, set it to 0

Example: If the lower set point is pH 4.0 and the hysteresis has been set at 0 50, a falling pH will cause the pump to activate at pH 3 50 and it will run until reaching set point (4 0)

4.2 Alarms

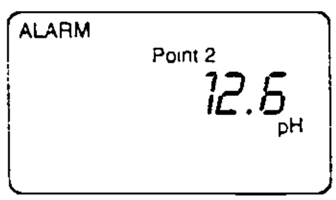
Note *Controller must be in 'OFF' mode to program change Set Points*

(1) ..... Press ALARMS to display Alarm data.



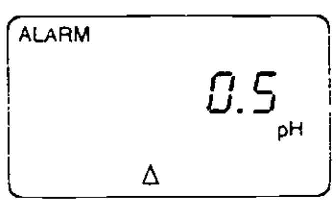
(2) ..... Press ▲ or ▼ to program Alarm Point 1 (low alarm)

(3) ...... Press ALARMS to save Alarm Point 1 value and to move to Alarm Point 2.



(4) ...... Press ▲ or ▼ to program Alarm Point 2 (high alarm)

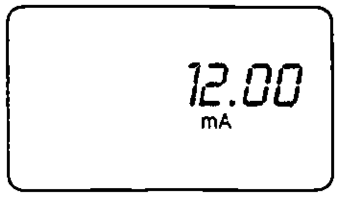
(5) ..... Press ALARMS to save Alarm Point 2 value and to move to Alarm Hysteresis



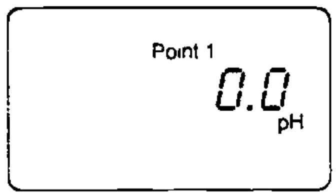
(6) ..... Press ▲ or ▼ to program Alarm Hysteresis This is the point where the alarm turns off.

'f the 4-20 mA option board is installed, the following screens will appear. If these do not appear and the 4-20 mA PCB is installed, go to Section 4.6, Advanced Menu, and program option "7" to "1" and option "6" to "1".

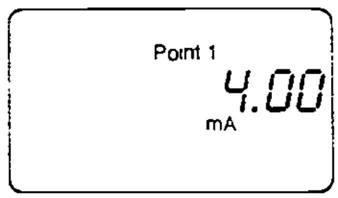
(7) ...... Press ALARMS/mA to display current mA output value.



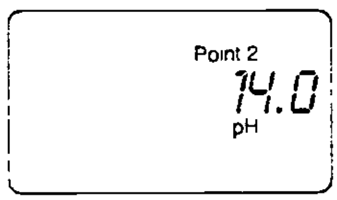
(8) ...... Press ALARMS/mA again to program the 4-20 mA output.



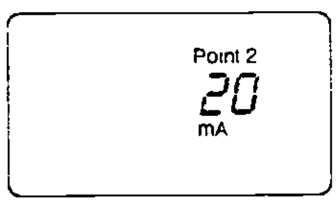
(9) ...... Press ▲ or ▼ to select the pH value for Point 1 mA output. Default is 4 mA + 0 pH, 20 mA =14 pH



'10) .... Press ALARMS/mA again Press ▲ or ▼ to select the mA value at Point 1.



(11) .... Press ALARMS/mA again Press ▲ or ▼ to select the pH value for Point 2 mA output.

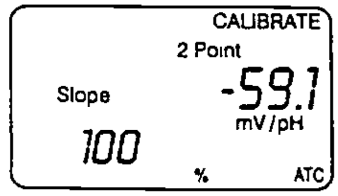


(12) .... Press ALARMS/mA again Press ▲ or ▼ to select the mA value at Point 2

685 213

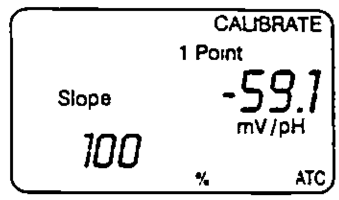
4.3 Calibration (Viewing Last Calibration Data)

Press the CALIBRATE / HOLD 5 SEC key once.



CALIBRATE will be visible and the 'mV/pH' and '%' (slope) of the previous calibration will be displayed. The display will alternate between 'mV/pH' and '°C.'

'2 Point' indicates that the previous calibration was a two-point calibration.



'1 Point' indicates that the previous calibration was a one-point calibration

4.4 Performing a New Calibration

For two-point calibration, the default settings are Buffer 1 = 7 00 pH and Buffer 2 = 10.00 pH but these values may be changed

Because it is not always possible to transfer the temperature probe from the process to the pH buffer, automatic temperature probe detection can be switched off in pH calibration mode.

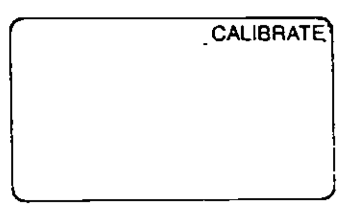
The calibration parameters (temperature, ATC [automatic temperature compensation] or manual, buffer pH and one or two point calibration) of the previous calibration are the initial values for the current calibration.

Note *If the LMI temperature cable and probe are connected, then the computer automatically selects and uses this ATC (automatic temperature compensation) during calibration If no temperature probe is connected, then 'MANUAL' will be selected during calibration. You must manually measure the temperature of the process being controlled and enter that value here*

Note *The unit must be placed in the 'OFF' mode The unit cannot be calibrated in the 'Run' mode.*

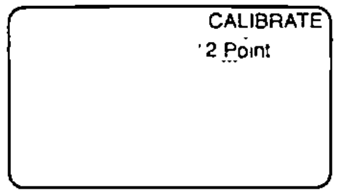
Calibration (e.g., 2 Point)

(1) ... .. CALIBRATE / HOLD 5 SEC + 5 seconds



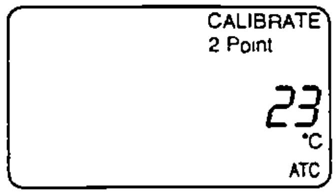
Hold the 'CALIBRATE' key down for five (5) seconds. 'CALIBRATE' will start flashing.

(2) ...... Press CALIBRATE / HOLD 5 SEC again

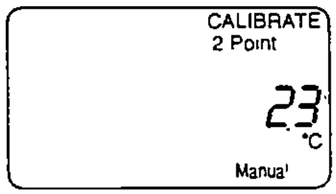


'2 Point' will start flashing. Use the ▲ or ▼ keys to toggle between '1 Point' and '2 Point.'

(3) ...... Press CALIBRATE / HOLD 5 SEC again 'ATC' (or 'MANUAL') will start flashing. Use the ▲ or ▼ keys to toggle between 'ATC' and 'MANUAL' temperature.



(4) ...... Press CALIBRATE / HOLD 5 SEC again Use ▲ or ▼ keys to program desired temperature.

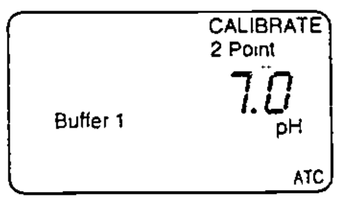


It is not possible to program temperature if 'ATC' is selected

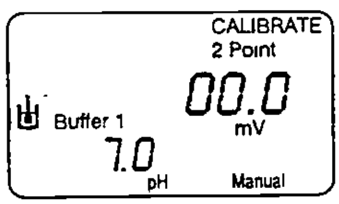
Note

Automatic temperature probe detection can be over-ridden in pH calibration mode If the ATC probe is not connected, the controller will not detect it and only the 'MANUAL' temperature option above will be displayed

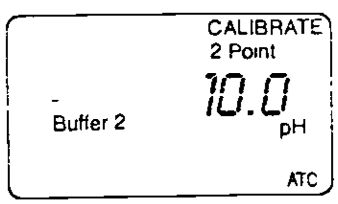
(5) ...... Press CALIBRATE / HOLD 5 SEC again. The 'Buffer 1' value will start flashing. Use ▲ or ▼ keys to program 'Buffer 1' pH (or leave at 7.0).



(6) ...... Press CALIBRATE / HOLD 5 SEC again The symbol will prompt you to put the probe in 'Buffer 1' Wait for the mV value to settle.

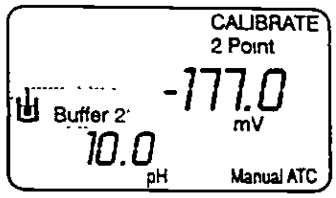


(7) ...... Press CALIBRATE / HOLD 5 SEC again This will accept the first calibration value and will display the 'Buffer 2' pH. Use ▲ or ▼ keys to program 'Buffer 2' (or leave) as desired.

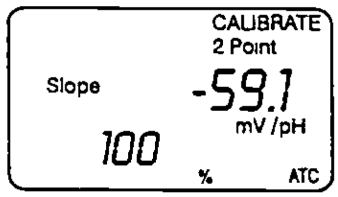


685 215

(8) ... Press CALIBRATE HOLD 5 SEC again and the symbol will prompt you to put the probe in 'Buffer 2' Wait for the mV value to settle.



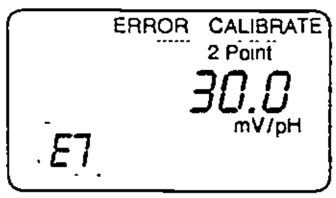
(9) . . . Press CALIBRATE HOLD 5 SEC again. This will accept the second calibration value and will display the 'mV/pH' (and '%' Slope) result of the calibration.



(10) .... Press CALIBRATE HOLD 5 SEC again to accept this calibration and exit calibration mode. Press any other key to abort calibration.

Note *For a single-point calibration, only one (1) buffer is used. The theoretical value for pH 7 00 is used to complete the Calibration Curve.*

If the calibration is unsuccessful (slope > 70% or offset > ± 30 mV) and 'ERROR CALIBRATE' and 'E7' are displayed; the calibration should be repeated or else the controller reverts to using the 'last successful' calibration performed



A slope of less than 70% indicates a dirty/faulty probe or contaminated buffer.

4.5 Pump Timers and Solenoid Valve Control Timers

It is not possible to change timer values while in 'RUN' mode. Unit must be in the 'OFF' mode to change values and settings

Pump Run Time:

This timer is set to the maximum time the pump can be on If the timer is set to over 11:10 hours, the pump will run continuously.

This timer is started when a pump is on and the pH value is outside the set points. The controller will stop the pumps when the time reaches '0' and activate 'ALARMS.' The run time is reset each time the pH enters the desired set point region.

Solenoid Delay Pump Valve Time:

The Solenoid Valve Relay output and the Auxiliary output may be activated when the pH is within the set points for the time specified by 'Delay 1.' This may be used for system integration and for emptying a batch tank etc.

The 'Delay 1' Timer defines the period to allow pH and system parameters to settle.

The 'Delay 2' Timer (ON time) defines how long the valve will stay open When these Delay Timers are active, pump dosing cannot take place but the DP5000 will monitor the pH The 'Delay 2' timer starts when the outputs are activated If the pH drifts outside of the set point and range, the solenoid relay will be deactivated

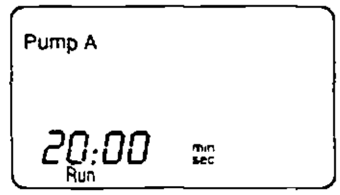
If a 'Delay 2' time goes below one hour, then the display will change to 'minutes : seconds' from 'hours minutes.'

Setting Timers:

Note *The unit must be in the 'OFF' (edit) mode to change the timer settings*

(1) .. .. Press the TIMERS key to view the run time for 'Pump A'.

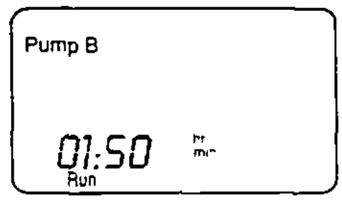
(2) ...... Use or to adjust to desired maximum run time.



Note *The 'hr . min' will change to 'min . sec' automatically as the run time is reduced below one (1) hour.*

(3) . . . Press the TIMERS key to advance to run time for 'Pump B'.

(4) ..... Use or to adjust to desired maximum run time



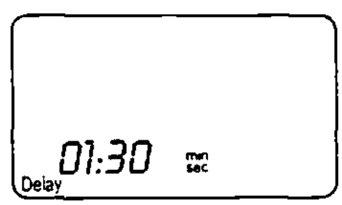
Note *The 'hr min' will change to 'min sec' automatically as the run time is reduced below one (1) hour*

Delay Timers are factory set in the deactivated mode. The 'Delay 1 and Delay 2' Timers are activated/deactivated in the 'Advanced Features Menu ' These screens will not display when the delay option is deactivated

Solenoid Valve Control:

(5) .. ... Press the TIMERS key to advance to 'Delay 1' time (if activated) 'Delay 1' is the wait time after pH enters the desired region, before the Solenoid is activated.

(6) ...... Press the TIMERS key to advance to 'Delay 2' time (if activated). 'Delay 2' is the Solenoid 'ON' time.

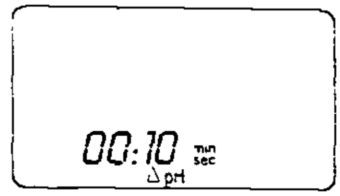


Note *If the pH should go out of the desired range during 'Delay1' or 'Delay 2', the Solenoid cycle will terminate.*

It will start again from zero when pH re-enters the desired region If pH remains in the desired region, the controller will enter 'OFF' mode at the end of the Solenoid 'ON' time. The controller turns 'ON', again in one minute and the cycle repeats

685,,217

(7) Press TIMERS key to advance to 'Response Rate' This is programmed in Δ pH units.



The smoothing of the input signal is determined by delta (pH) time. The 'Response Rate' is the time that the computer display takes before it updates the pH readings.

The following values can be programmed (min . sec).
00 : 01 00 10 00 : 2000 : 30. . . . 04 . 00

When 00 . 01 is programmed the controller responds to a change in input in one (1) second.

If 00 · 10 is selected the controller responds to a change in input in ten (10) seconds (i e., the value displayed is the average of the 10 previous 1 second readings)

Examples: The sampling time (delta) is 00 : 10 and the current reading is 2.00 pH.

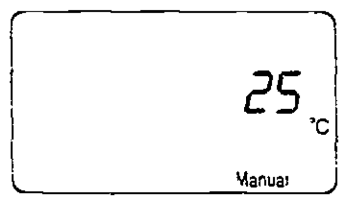
When the pH input is increased instantaneously to 12.00 pH, the display will respond as follows.

Seconds	0	1	2	3	4	5	6	7	8	9	10	11
pH	2	3	4	5	6	7	8	9	10	11	12	12

If the sampling was 00 01 seconds, the response would be

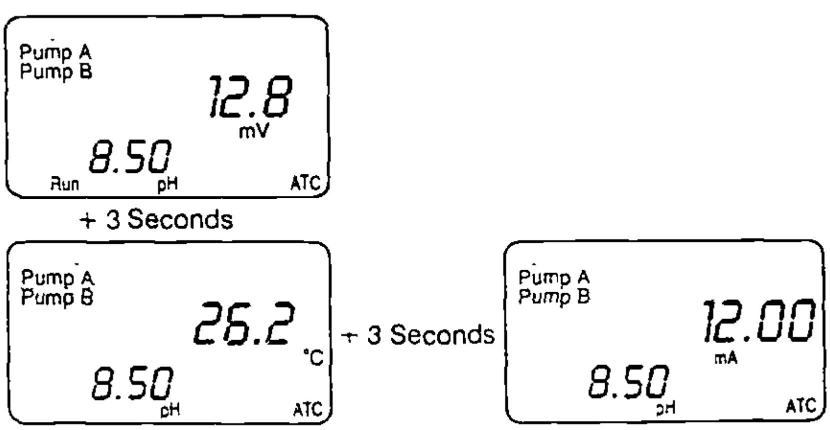
Seconds	0	1	2	3	4	5	6	7	8	9	10	11
pH	2	12	12	12	12	12	12	12	12	12	12	12

Press the TIMERS key to advance to set temperature
This setting is relevant when no temperature probe (1000 Ω platinum RTD) is connected.



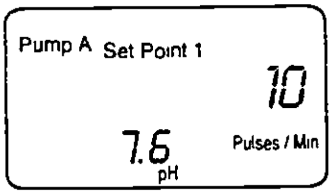
Display Key:

While in the Run Mode the DISPLAY key can be pressed once to display current parameters Each screen will come up for three (3) seconds and then returns to pH display or System Run automatically (screens shown below are: mV, °C, and mA).

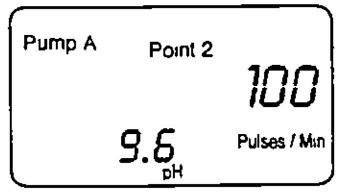


Similarly, the Pump Control Points can be displayed while in the 'RUN' Mode by pressing the 'Pump A' or 'Pump B' keys once.

ress ACID PUMP A and the following screens display:



+3 Seconds



4.6 Advanced Menu List:

Holding the DISPLAY key for five (5) seconds accesses the 'Advanced Features' Menu, and allows these settings to be changed.

Press the 'DISPLAY/MENU' key for five (5) seconds while the controller is in the 'EDIT' or 'OFF' mode.

The first item displayed is the software revision. Pressing 'Display/Menu' again cycles to the first option. The first number is the option. The second is the setting. Use the ⇑ or ⇓ to change the setting.

Option	Setting	
1	1 0	Control returns to **Run** 60 seconds after last keypress **Run/Edit** key is **On/Off**
2	1 0 2	**On/Off** Control **Proportional** Control (and **On/Off**) **Proportional** Control
3	1 0	Point 3 Programming Enabled Point 3 Programming Disabled (Two point only)
4	1 0	Solenoid programmed to switch on after programmed time 'DELAY 1' and to switch **Off** after programmed time 'DELAY 2' Solenoid Disabled
5	1 0	Communications Enabled - Option Board must be fitted Communications Disabled
6	1 0	mA Enabled - Option Board must be fitted mA Disabled
7	1 0	Allows editing of #5 & #6 Lockout #5 and #6

Note

The Option Board (34310) is required for Options 5 and 6

685 219

5.0 Maintenance

5.1 pH Electrode and Cable

The most frequently replaced part is the pH electrode (not supplied with controller), which will deteriorate with age Refillable electrodes should be checked for level frequently, and replenished with filling solution as necessary. An electrode may also fail because of

- aging (slow response to changing pH)
- coatings over the glass bulb (slow response to changing pH)
- abrasion of the glass bulb (shift in calibration)
- chemical attack
- breakage

If you experience instability or lack of response, check the electrode, replace if necessary and recalibrate. Follow manufacturer's recommendation for cleaning the electrode.

Take care not to damage input cables, or allow the connections to get wet.

6.0 Troubleshooting

Troubleshooting and repair of the malfunctioning unit should only be attempted by qualified personnel using caution to ensure safety and limit unnecessary damage.

Should an error or alarm condition occur, the controller will alert the operator to this by flashing an 'ERROR MESSAGF These messages are depicted on the following page with a brief explanation.

685 220

6.1 Error Messages

Note *Turn system off to clear error message*

Display	Message
E1	E1 = LOW LEVEL
E2	E2 = FLOW SWITCH
E3	E3 = ALARM 1: LOW ORP
E4	E4 = ALARM 2: HIGH ORP
E5	E5 = Pump B 'LOCKOUT
E6	E6 = Pump A 'LOCKOUT
E7	E7 = CALIBRATION ERROR Probe is out of Manufacturer's Limits
E9	E9 = FAULTY/DISCONNECTED PROBE

7.0 DP5000 Specifications

Power Requirements	115 VAC ±15%, 60 Hz 230 VAC ±15%, 50 Hz Voltage input selectable via a selector switch located on the I/O PCB.
Inputs	Flow Switch, Auxiliary Inputs, Remote ON/OFF, Spares All low voltage inputs active low, i.e., the active state is when the switch is closed. The switch must be capable of switching 2 mA at ± 15 VDC.
Outputs	Pulse Pump A and B, Auxiliary, Alarm. All low voltage outputs capable of switching 2 mA at + 24 VDC The pulse output frequency range will be 0-100 per minute. The pulse output active low. The pulse width 100 ms in the active (low) state.
Output Type:	Opto-Isolated NPN transistor open collector configuration.
Keypad	Nine key membrane keypad with tactile response.
Material:	(The switches are multiplexed 3 x 3.)
Actuation Force:	Polyester with a hard coat finish
Travel:	2.6 N to 3.3 N
Termination Connector:	0.65 mm 6-way gold plated Berg clincher type 65801-035
Temperature Input	The temperature input interfaces to a platinum 1000 ohm RTD probe
Probe.	PT1000 (Platinum, 1000 Ω base resistance)
Circuit Accuracy:	± 0 9° F (± 0.5° C)
Temperature Display	32° F to 212° F (0° C to100° C)
Temperature Resolution	± 1 8° F (± 1° C)
pH Probe Input	
Accuracy	± 0.02 pH (500M Ω probe ambient cycle 32° F to 113° F [0° C to 45° C])
Resolution:	0 01 pH
Input pH Range:	0-14 pH
Input Impedance Differential:	10^{13} Ω
Input Impedance Common	10^{16} Ω
ESD Protection	700 V
Relays	Fuse protected
Alarm Relays (2)	Electromechanical
Solenoid Valve Relay (1):	115/230 VAC, 10 A/6 A
Current/Voltage Rating:	10A, 115 VAC or 6A, 230 VAC
Contact Type:	Normally open and normally closed contacts (FORM C) Change over relay
Pump ON/OFF Relay (2)	115 V/230 VAC, 10 A/6 A (NO)
(ON/OFF CONTROL)	ON/OFF Relays are Fuse Protected (FORM C) Normally open relay
Fuse	10 A, 250 VAC time delay (Anti-surge)
LCD Display	
Operating Voltage.	5 V
Operating Temperature	32° F to +158° F (0° C to +70° C)
Viewing Area:	1.2 x 1.8 inches (30 x 46 mm)
Backlight:	An 8 emitter (dual LED type), double row, reflective backed, backlight module will be used. The light output color and reflective backing color will be high performance green.
Memory Backup	EEPROM
Data Retention No Power:	10 year minimum

Pre-amplifier
Output Voltages ______

Voltage:	± 5 V
Output Voltage Tolerance:	± 5% maximum
Current Output:	± 10 mA maximum

Computer
Communications ______

Serial RS232:	Outputs to EIA/TIA-232E Specifications ESD protected to ± 8KV contact discharge using IEC801-2, ± 15 KV air gap using IEC801-2 air gap method and ± 15 KV human body model.
4-20 mA Load:	500 ohms maximum resistance
Accuracy:	± 0.2 mA - The 0-20 mA shares a common ground with +15 V and the low voltage inputs.

Control Outputs

(Pump A / Pump B) (Proportional Control)	Opto-Isolated Open Collector (2 mA)
Fault:	Opto-Isolated Open Collector (2 mA)

Control Inputs

Remote ON / OFF	Opto-Isolated (2 mA)
Flow Switch:	Opto-Isolated (2 mA)
Low Level Input	Opto-Isolated (2 mA)
Aux (spare):	Opto-Isolated (2 mA)

Environmental ______	Printed Circuit Boards conformally coated
Operating Temperature	32° F to 113° F (0° C to 45° C)
Enclosure.	IEC IP65, NEMA 4X

Mechanical ______	Two printed circuit boards (3 if option installed)
Control Board.	(Microcontroller & Display) - Low Voltage
Terminal/Power Board	Transformer, fuses, terminal blocks, relays
Option Board:	(0-20 mA output and Communications) - Low Voltage

8.0 Program Log

For record keeping, a program log is provided below.

	Proportional Pt 1	Proportional Pt 2	ON/OFF	Proportional Pt 1	Proportional Pt 2	ON/OFF
Pump A Set Point	7.5	10 5	7.5			
Pump A Pulses/Min	20	90	///			
Pump B Set Point	6.5	2.5	6.5			
Pump B Pulses/Min	30	65	///			
Hysteresis 1	///	///	0.5			
Hysteresis 2	///	///	0.5			

	Alarms	
Alarm 1	2.0 pH	
Alarm 2	12.5 pH	
Hysteresis	0 5 pH	

	mA Response	
Current Low	4.0 mA	
Signal Low	0.0 pH	
Current High	20 0 mA	
Signal High	14.0 pH	

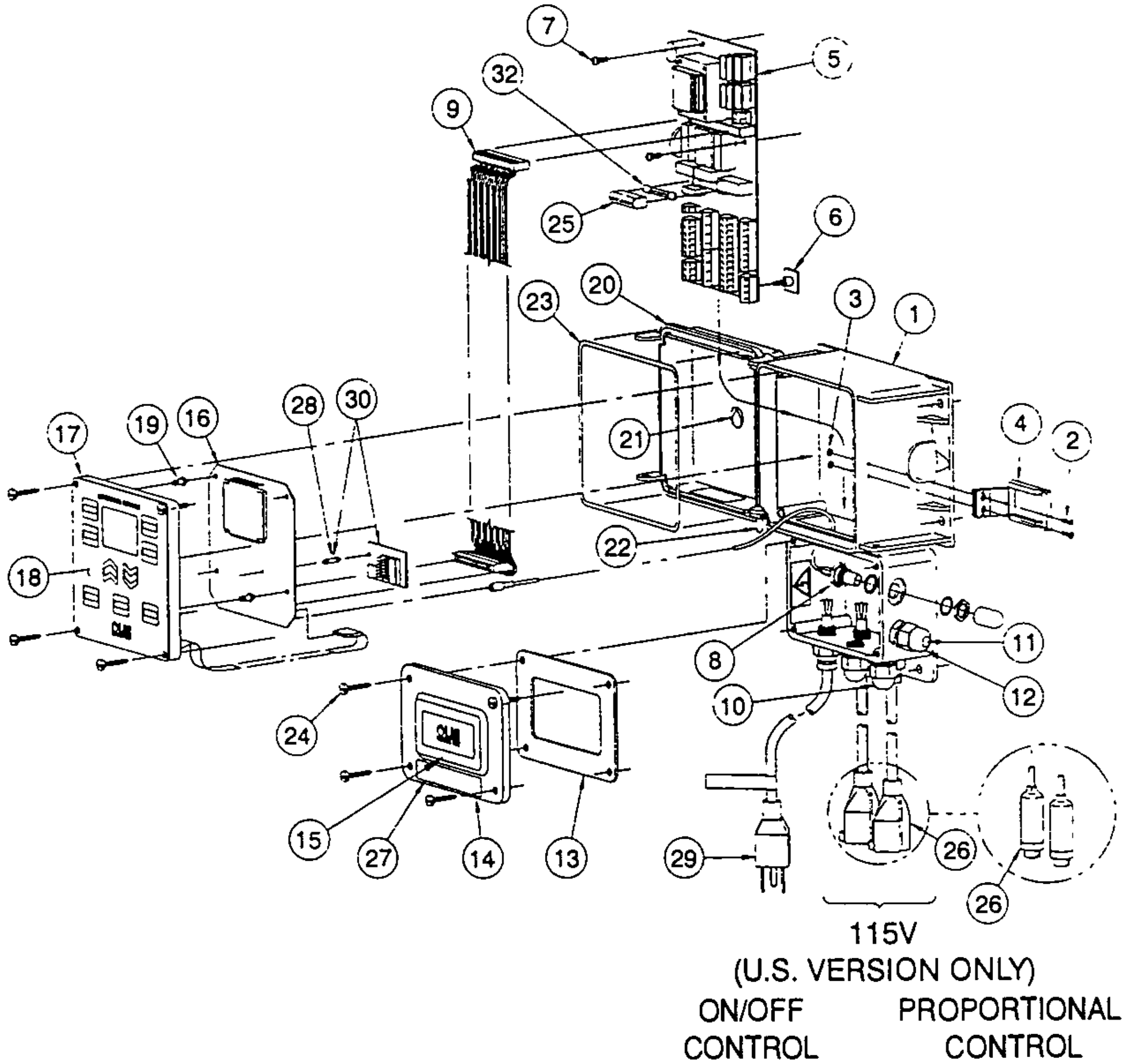
	Timers	
Pump A On-Time	20:00 Min	
Pump B On-Time	30:00 Min	
Sampling Time	00:10 Min	
Delay to Solenoid ON	5:00 Min	
Solenoid On-Time	20.00 Min	
Temperature	24°C	

	Calibration	
Number of Points	2	
Buffer Temperature	Manual	
Buffer Temperature	24	
Buffer 1	7.0	
Buffer 2	10.0	

9.0 Parts List

Key No.	Part No.	Description
1	34691	Housing, Machined
2	32186	Screw, 4-40 x .37
3	32187	Nut, 4-40 Flush
4	32209	Latch, Machined
5	34270	I/O Board Assembly
6	34716	Standoff, Self Adhesive
7	31632	Screw, #6 x .38
8	34329	BNC Cable Assembly
9	34330	Ribbon Cable Assembly
10	25957-1	Cord Clamp
11	36810	Dowel
12	31571	Clamp, Cord (PG-9)
13	34074	Gasket, Foam
14	34088	Cover, Utility Box
15	30588	Label
16	34200	CPU Board Assembly
17	31423	Panel
18	34092	Switch Membrane
19	31576	Standoff
20	31617	Cover, Liquitron™
21	32094	Label
22	32211	Cap, 125 x .38
23	32352	O-Ring, Sponge
24	32395	Screw, Self-Tapping
25	34911	Cover, Fuse
26	35711	Cord, Power, 115V, NEMA 15-R - DP5000-XA (On/Off)
	33636	4-Pin Cable - DP5000-XB (Proportional)
27	34930	Terminal Cover Label
28	34315	PCB Support
29	30749	Power Cord 115V - DP5000-1A/B
	30751	Power Cord 220V US - DP5000-2A/B
	30752	Power Cord DIN - DP5000-3A/B
	34783	Cord Assembly UK - DP5000-5A/B
	30754	Power Cord AUST - DP5000-6A/B
	34784	Cord Assembly SWISS - DP5000-7A/B
30	34310	4-20mA Circuit Board Assembly w/ support
32	35712	Fuse, 4A Time Delay

10.0 Exploded View



685 226.

Technology For Solutions

GLI International

Data Sheet 692PR/299
Supersedes 692PR/398

Model 692 Two-Wire pH and ORP Transmitters

CE

Certified Compliant to
European Community Standards

Hazardous Area Certifications

- Certified by UL and CSA as intrinsically safe for:
  Class I, Division I
  Groups A, B, C, and D

  Class II, Division I,
  Groups E, F, and G

- Certified by CSA for Division 2.

- Certified compliant as intrinsically safe to CENELEC standards for:
  Zones 0 and 1, Groups IIC through IIA

■ **Multiple Readouts.**
Four measured variables can be alternately displayed. pH, temperature (°C or °F), the sensor's mV signal, and the 4-20 mA output. Indication for the 692R is similar except without a readout for pH.

■ **Simple Automated Calibration.**
Conventional single and two-point methods can be used to enter buffer values into memory. However, an additional calibration method is provided which is especially convenient for a novice operator because it eliminates the need to enter buffer values. The operator need only place the sensor in the appropriate buffer for each calibration point (values are pre-entered by qualified person), press a key to begin calibration, wait for annunciators to stop flashing, and press a key to end calibration.

■ **Built-in pH versus Temperature Table.**
For extremely accurate calibration, choose pH buffer values from a built-in table with related temperature curves. The 692P monitors the temperature and time response when the sensor is in a buffer.

■ **Easy Setup and Operation.**
The 692P is microprocessor-based and menu-driven for enhanced, convenient push-button operation.

■ **Accepts Differential or Conventional Sensor.**
The 692P may be used with a GLI 5-wire Differential Technique sensor or a conventional combination electrode with integral or separate temperature sensor. A Pt 1000 RTD or 300 ohm thermistor may be used for automatic temperature compensation.

■ **Diagnostics Identify Problems.**
Build-in diagnostics provide error messages identifying abnormal system operating conditions such as an out-of-range input or loss of memory.

■ **NEMA 4X Protection.**
The NEMA 4X enclosure features a unique terminal strip compartment with separate access and weatherproof seals, permitting electrical hookup without exposing instrument circuitry to the environment.

pH/ORP

Specifications

Operational:

Display .... 4-1/2 digit LCD with measurement unit and setup variable identifiers, 7/8 inch (22 mm) high digits

Measuring Ranges

Model 692P: pH .... 0.00 to 14.00 pH
Temperature .... 14.0 to 230.0°F (-10.0 to +110.0°C)
Millivolts .... (-)500 to (+)500 mV
Output Current .... 4.00 to 20.00 mA

Model 692R: Temperature .... 14.0 to 230.0°F (-10.0 to +110.0°C)
Millivolts .... (-)2000 to (+)2000 mV
Output Current .... 4.00 to 20.00 mA

Ambient Conditions .... -22 to +122°F (-30 to +50°C), 0 to 95% relative humidity, non-condensing

Temperature Compensation .... Automatic 32-212°F (0-100°C), switch selectable for 300 ohm thermistor or Pt 1000 RTD

Sensor-to-Transmitter Distance .... 3000 ft. (914 m) max. for GLI 5-wire Differential Technique sensor; 10 ft. (3 m) max. for direct connection of conventional combination electrode (a GLI Model 714 preamplifier is required for distances greater than 10 ft./3 m)

Power Requirements .... 16 to 40 volts DC

Analog Output .... Isolated 4-20 mA with output hold feature

Range Expand – The 4-20 mA output can be made to represent a one pH unit of larger segment of the measuring scale (50 mV or larger segment for Model 692R transmitter).

^Δ^Maximum Loop Load .... With 24 VDC supply: 400 ohms
(load in series with Model 692 transmitter and power supply) With 32 VDC supply: 800 ohms
With 36 VDC supply: 1200 ohms

NOTE: *For long cable runs, the resistance of the wire must be considered and may decrease maximum load capability*

^Δ^Not applicable when using barrier for intrinsic safety

Certified CE Compliant (optional) .... Complies to European Community standards for electromagnetic and radio frequency emissions and susceptibility (EC directive 89/336/EEC)

Hazardous Area Certification (optional):

Intrinsic Safety .... UL and CSA: Class I, Division 1, Groups A, B, C, and D
Class II, Division 1, Groups E, F, and G

CENELEC: *Zone 0 and Zone 1, Groups IIC through IIA*

Division 2 .... CSA: Class I, Division 2, Groups A, B, C, and D
Class II, Division 2, Groups E, F, and G

Transmitter Performance (Electrical, Analog Outputs):

Sensitivity .... 0.05% of span

Stability .... *0.05% of span per 24 hrs., non-cumulative*

Non-linearity .... 0.05% of span

Repeatability .... 0.1% of span or better

Temperature Drift .... Zero: 0.01% of span per°C;
Span: 0.01% of span per°C

Response Time .... 1 second to 90% of value upon step change

Mechanical:

Enclosure .... General purpose - safe for Division 2; NEMA 4X, polycarbonate with two 1/2 inch conduit holes and four stainless steel mounting tabs

Mounting Configurations .... Surface mount; optional vertical or horizontal pipe mounting

Net Weight .... 3 lbs. (1.36 kg) approximately

Ordering Information

MODEL NUMBER
692P3F5A pH transmitter in NEMA 4X enclosure.
692R3F5A ORP transmitter in NEMA 4X enclosure.

INPUT CAPABILITY
7 For GLI 5-wire Differential Technique sensor
8 For conventional combination electrode

EQUIPMENT TAGGING (specify tag data)
N None **P** Paper **S** Stainless steel

AGENCY CERTIFICATION
N None (safe area use only)
D CSA Certified (Div. 2 intrinsically safe)
E Certified CE Compliant (safe area use only)
H CSA Certified (Div. 1 intrinsically safe)
J CENELEC (Zone 0 and Zone 1 intrinsically safe)
L CENELEC (Zone 0 and Zone 1 intrinsically safe) and CE compliant
U UL Classified (Div 1 intrinsically safe)

Product Number

Choose one from each category.

Accessories (order separately):

- **Input Board 692G1105**— Enables transmitter to be retrofitted for use with a conventional combination electrode.
- **Sensors** — Refer to data sheets LCP, Epoxy, 6000P0, FTA, 6300, RP6300, and 6314
- **Pipe Mounting Hardware Kit 1000G3065** — Enables transmitter to be mounted onto horizontal or vertical pipe.
- **Power Supplies** — Model 841 powers up to six transmitter loops; Model 844 powers up to three loops For details, see data sheet 841.
- **Intrinsic Safety Barrier** — It is recommended to use barrier 1F1054 and the Model 841 power supply for applications requiring cable lengths of up to 3000 ft. (914 m) on the hazardous area side and up to 6000 ft. (1829 m) on the safe area side (Distances are decreased for CENELEC-approved Model 692. In this case, refer to GLI control drawing 1001X4N1266)

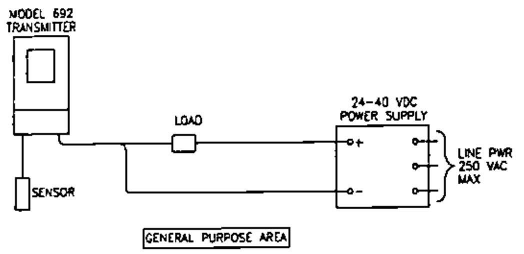
NOTE: *Barrier and power supply selection are also dependent on cable type and, if applicable, the size (in ohms or voltage drop) of a repeated load For additional information, consult GLI.*

Engineering Specification

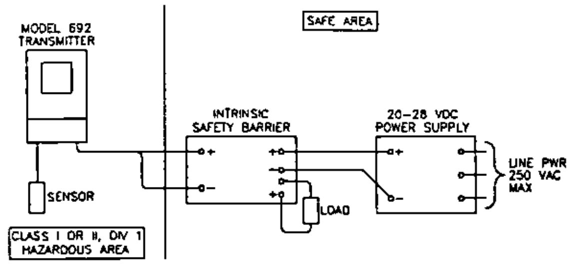
1. The microprocessor-based transmitter shall accept
   a) GLI 5-wire Differential Technique sensor.
   b) Conventional combination electrode with integral or separate temperature sensor
2. The transmitter shall convert the sensor signal to a standard 4-20 mA signal that represents the 0 00 to 14 00 pH measuring scale.
3. The transmitter shall use only two wires for output and power transmission.
4. The transmitter shall have a 4-1/2 digit LCD readout with 7/8 inch (22 mm) high digits and be capable of indicating the measured pH (Model 692P only), temperature (°C or °F), the sensor's mV signal, and the 4-20 mA output
5. The transmitter shall automatically flash preprogrammed diagnostic messages whenever system operating problems are detected.
6. The transmitter shall have pass coding for restricted access to instrument settings.
7. The transmitter shall have four pH calibration methods (Model 692P only):
   a) Conventional single point method where the operator enters one pH buffer value into memory.
   b) Conventional two-point method where the operator enters two pH buffer values into memory
   c) "Two-key" two-point method where two pH buffer values are pre-entered by a qualified person and, anytime thereafter, a novice operator can calibrate by simply pressing two keys.
   d) "Two-key" table method which is similar to the "two-key" two-point method except that the buffer values -- and their related pH vs. temperature curves -- are selected from a table of 14 specific buffer formulations.
8. The transmitter shall have an isolated 4-20 mA output and a range expand feature, enabling the output to represent the entire measuring scale or a selected segment of it, and be direct or reverse acting.
9. The transmitter shall have an output hold feature, activated using the keypad, to maintain the latest output during calibration or while configuring the instrument
10. The transmitter shall be housed in a NEMA 4X enclosure for surface mounting and include a terminal strip compartment with separate access and weatherproof seals, permitting electrical hookup without exposing instrument circuitry to the environment.
11. The transmitter shall be GLI International, Inc. Model 692P (pH) or Model 692R (ORP)

685 229

Typical Wiring System



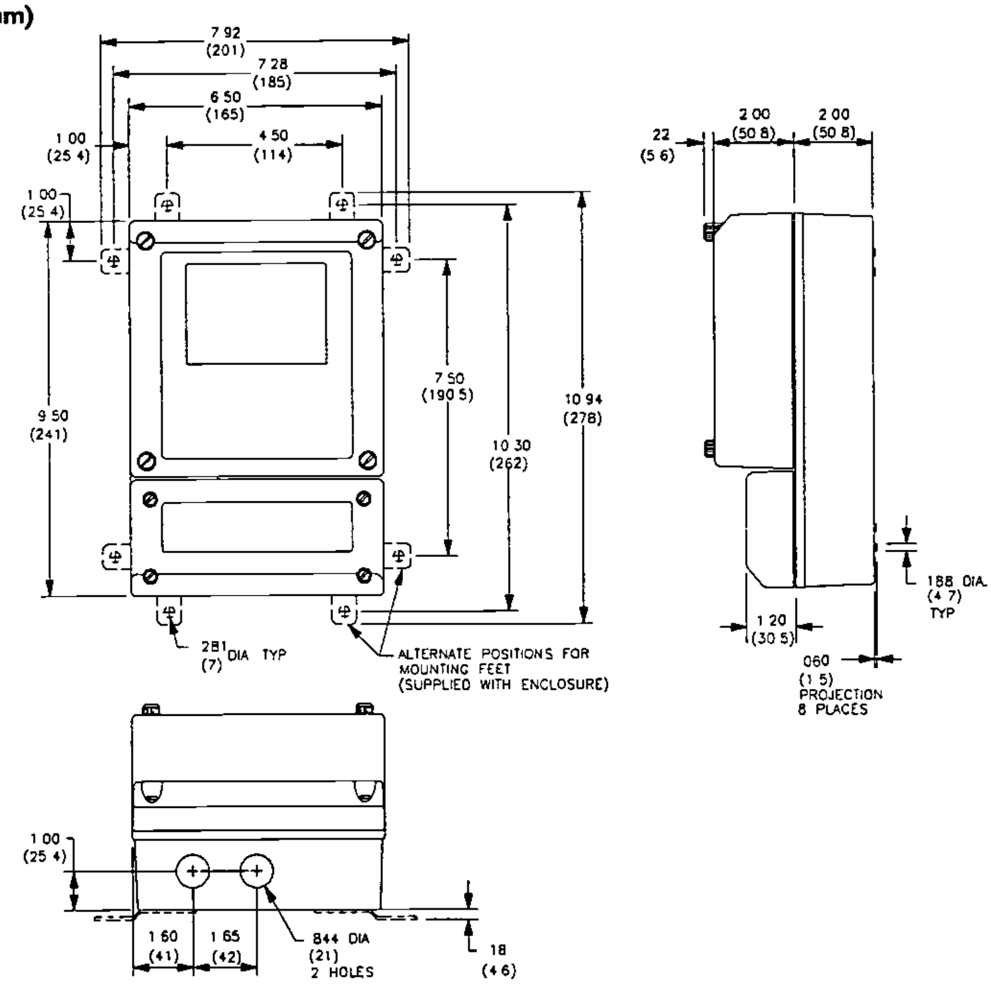
General Purpose Area Use (Powered without Barrier)



Hazardous Area Use (Powered through Barrier)

Dimensions

Inches (mm)



Data Sheet 692PR

Worldwide Sales:
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9020 West Dean Road
Milwaukee, Wisconsin 53224, U.S.A.
phone [414] 355-3601
fax [414] 355-8346
e-mail info@glint com

European Sales:
GLI International Ltd
Eastman Way, Hemel Hempstead
Hertfordshire, HP2 7HB England
phone 01442 229310
fax 01442 229311
e-mail gli@gli co uk

685 230

GREAT LAKES INSTRUMENTS

OPERATING INSTRUCTION MANUAL

Manual No. 692P
Revision 7-193

MODEL 692P
TWO-WIRE
pH TRANSMITTER

Great Lakes Instruments, Inc.
9020 West Dean Road, Milwaukee, Wisconsin 53224 • Telephone (414) 355-3601 • Telefax (414) 355-8346

Page(s) 2

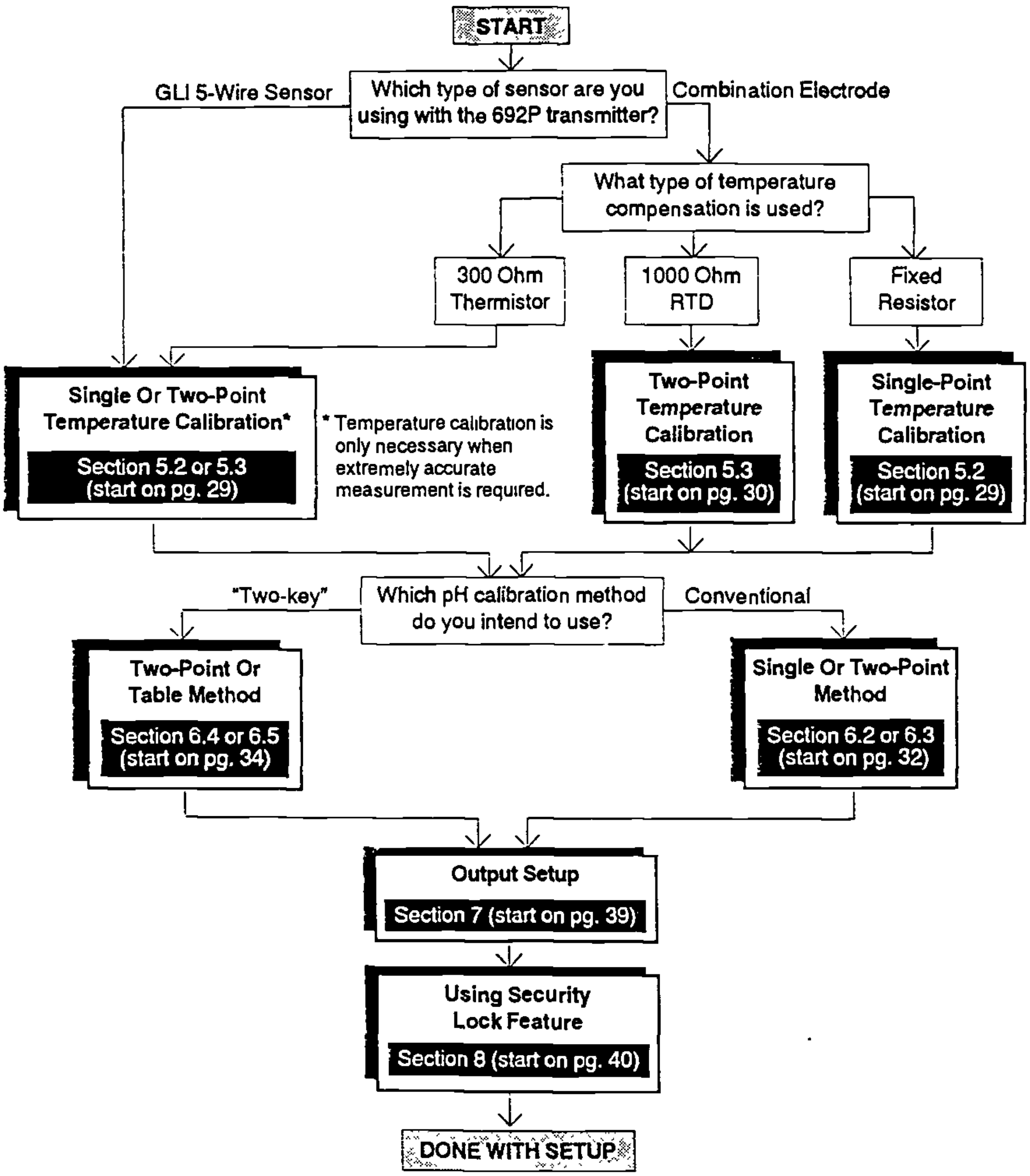
are Missing from the

Official Government

Document

INSTRUMENT SETUP GUIDE

This manual contains detailed instructions for all operating aspects of this instrument. Read Part One for a general description of the Model 692P. Part Two explains how to install and wire the instrument. To familiarize yourself with the basic operation of the 692P, read Part Three, Sections 1, 2 and 3. For instrument startup, perform the setup steps in Section 4. The following guide shows which subsections of Sections 5 and 6 to use for calibration when using a GLI 5-wire Differential Technique sensor or a conventional pH combination electrode.



685 233

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

685 235

TABLE OF CONTENTS (Continued)

PART FOUR - OPERATING AIDS

PART FIVE - PRINCIPLE OF OPERATION

PART SIX - SERVICE AND MAINTENANCE

PART SEVEN - SPARE PARTS AND ACCESSORIES

TABLE OF CONTENTS (Continued)

685 237

PART ONE - INTRODUCTION

SECTION 1 - GENERAL INFORMATION

1.1 Instrument Capability

Input Versatility

The instrument may be used with any GLI Differential Technique pH sensor that has an integral preamplifier (identified by its 5-wire cable) or a conventional pH combination electrode with integral or separate temperature sensor. A switch is provided to configure the instrument for use with a 300 ohm thermistor or 1000 ohm RTD temperature sensor input for temperature compensation.

Display Readouts

The large liquid crystal display can alternately indicate four variables: pH, temperature (in °C or °F), the sensor's mV signal, or the 4-20 mA instrument output.

Operator Interface

Abbreviated identifiers are shown along with their related numerical values to provide understandable readouts for instrument setup, calibration and process monitoring. Procedure messages prompt the operator during instrument setup and calibration. System diagnostic error messages flash whenever the instrument detects an out-of-range input for pH and/or temperature or a memory loss.

Output Flexibility

The 4-20 mA instrument output, which tracks the measured pH, is isolated to eliminate problems caused by ground loops. An output hold feature can be used to maintain the latest output during calibration or instrument setup to suspend operation of a receiving device. A range expand feature allows the 4-20 mA output to represent a one pH unit or larger segment of the measuring scale.

Operator Safety

Modular construction simplifies field servicing and provides electrical safety for the operator. The printed circuit module assemblies contain voltages no greater than 24 VDC and are safe to handle. A terminal strip compartment, with separate access and weatherproof seals, permits electrical hookup without exposing the instrument circuitry to the environment.

1.2 Battery Back-up

A lithium battery on the backside of the display board retains all user-entered setup values for approximately one year (at 25°C), when loop power is removed. The battery's capacity is one year of backup time which can occur over a period of up to 10 years. A **BATTERY ON/OFF** jumper is located next to the battery to disconnect the battery when the instrument is not used for an extended time.

NOTE: If the instrument is operated with the battery switched *off, user-entered values are stored only as long as power is applied. When power is removed, all stored values will be lost. Factory-set defaults will replace all user-entered values when power is re-applied.*

The back-up battery is replaceable.

WARNING: FOR HAZARDOUS AREA APPLICATIONS, THE 692P TRANSMITTER MUST BE MOVED TO A SAFE AREA FOR BATTERY REPLACEMENT, IF NEEDED.

1.3 Product Identification

The serial # of your instrument is located at the top of the backside of the display module assembly (Figure 3-2). The matrix below lists all of the instrument options. Use it as a handy reference when re-ordering. Write the serial # in the space provided below the matrix for convenient identification should technical assistance be required.

MODEL NUMBER
692P3 Microprocessor-based two-wire transmitter in NEMA 4X surface-mount enclosure with stainless steel mounting tabs.

ANALOG OUTPUT
F Isolated 4-20 mA

LINE VOLTAGE
5A 24 VDC

INPUT CAPABILITY
7 Accepts GLI 5-wire sensor
8 Accepts conventional combination electrode

N Standard Instrument
K Special Instrument

692P3 F 5A --- **Product Number**

Serial # ______________________

685 239

SECTION 2 - SPECIFICATIONS

2.1 Operational

Display .... 4-1/2 digit LCD with measurement unit and setup variable identifiers, 7/8" high digits

Measuring Range:

- pH .... 0.00 to 14.00 pH
- mV .... (–)500 to (+)500 millivolts
- Temperature .... (–)10.0 to (+)110.0°C (14 to 230°F)

Ambient Conditions .... –30 to 50°C (–22 to 122°F), 0 to 95% relative humidity, non-condensing

Temperature Compensation .... Automatic, 0-100°C (32-212°F), 300 ohm thermistor or Pt 1000 RTD, switch selectable

Sensor-to-Transmitter Distance .... 3000 feet maximum for GLI 5-Wire Differential Technique sensor
-or-
10 feet maximum for direct connection of combination electrode (a GLI Model 714 preamp is required for distances greater than 10 feet)

Power Requirements .... 16 to 40 volts DC

Analog Output .... Isolated 4-20 mA with output hold feature

Range Expand - The 4-20 mA output can be made to represent a one pH unit or larger segment of the measuring scale.

Hazardous Area Classification:

Intrinsic Safety .... UL and CSA: Class I, Div. 1 Groups A,B,C and D
Class II, Div.1. Groups E,F and G

▲Maximum Loop Load (in series with 692P and power supply) .... With 24 VDC supply: 400 ohms
With 32 VDC supply: 800 ohms
With 40 VDC supply: 1200 ohms

NOTE – For long cable runs, the resistance of the wire must be considered and may decrease maximum load capability.

▲Not applicable when using barrier for intrinsic safety.

2.2 Analyzer Performance (Electrical, Analog Output)

Sensitivity .... 0.05% of span

Stability .... 0.05% of span per 24 hrs., non-cumulative

Non-linearity .... 0.05% of span

Repeatability .... 0.05% of span or better

Temperature Drift .... Zero: 0.01% of span per °C
Span: 0.01% of span per°C

Response Time .... 1 second to 90% of value upon step change

2.3 Mechanical

Enclosure .... General purpose—safe for Division 2; NEMA 4X, polycarbonate with two 1/2-inch conduit holes and four stainless steel mounting tabs

Mounting Configurations .... Surface mount, optional vertical or horizontal pipe mounting

Net Weight .... 3 lbs. (1.36 kg) approx.

PART TWO - INSTALLATION

SECTION 1 - UNPACKING

After unpacking, it is recommended to save the shipping carton and packing materials in case the instrument is stored or re-shipped. Inspect the equipment and carton for damage. If there is evidence of shipping damage, notify the carrier immediately.

SECTION 2 - MECHANICAL REQUIREMENTS

2.1 Location

The Model 692 is designed intrinsically safe. That is, an explosionproof enclosure is not required when the transmitter, powered through a suitable barrier, is located in Class I or II, Division 1 hazardous areas.

WARNING: THE POWER SUPPLY AND INTRINSIC SAFETY BARRIER MUST ALWAYS BE LOCATED IN A SAFE AREA.

1. Locate the 692P within 3000 feet of where the GLI 5-wire Differential Technique sensor is to be installed. If a combination electrode is used, the 692P must be within 10 feet of the electrode for a direct cable run. A GLI Model 714 preamp may be used to extend this distance to 3000 feet, but the preamp must be within 10 feet of the electrode.
2. Mount the 692P in a location that is:
   - Clean and dry where little or no vibration exists.
   - Protected from falling corrosive fluids.
   - Within ambient temperature limits (-22 to 122°F, -30 to 50°C).

   CAUTION: MOUNTING IN DIRECT SUNLIGHT MAY INCREASE TEMPERATURE ABOVE MAX. LIMIT.

2.2 Mounting

Refer to Figure 2-1 for enclosure and mounting dimension details. Figure 2-2 illustrates various mounting configurations. Use the four stainless steel tabs to surface-mount the instrument. An optional hardware kit is required for pipe-mounting. The bracket attachment method determines vertical or horizontal pipe mounting configuration.

685 241

To surface mount the 692P:

1. Place tabs in appropriate locations on back of enclosure and fasten with screws provided.
2. Position instrument on flat surface and use appropriate fasteners to secure it in place.

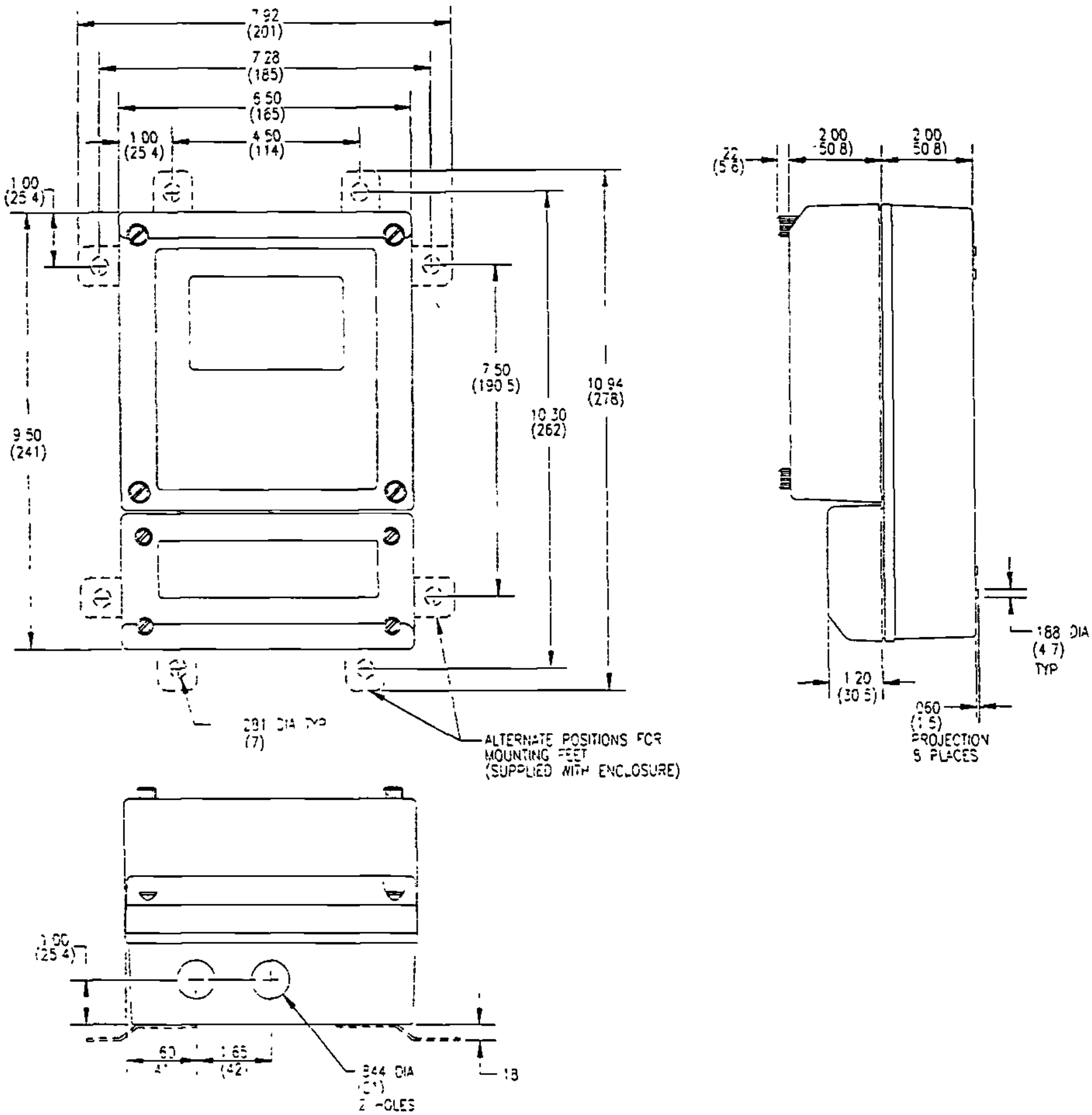


FIGURE 2-1 Enclosure Outline

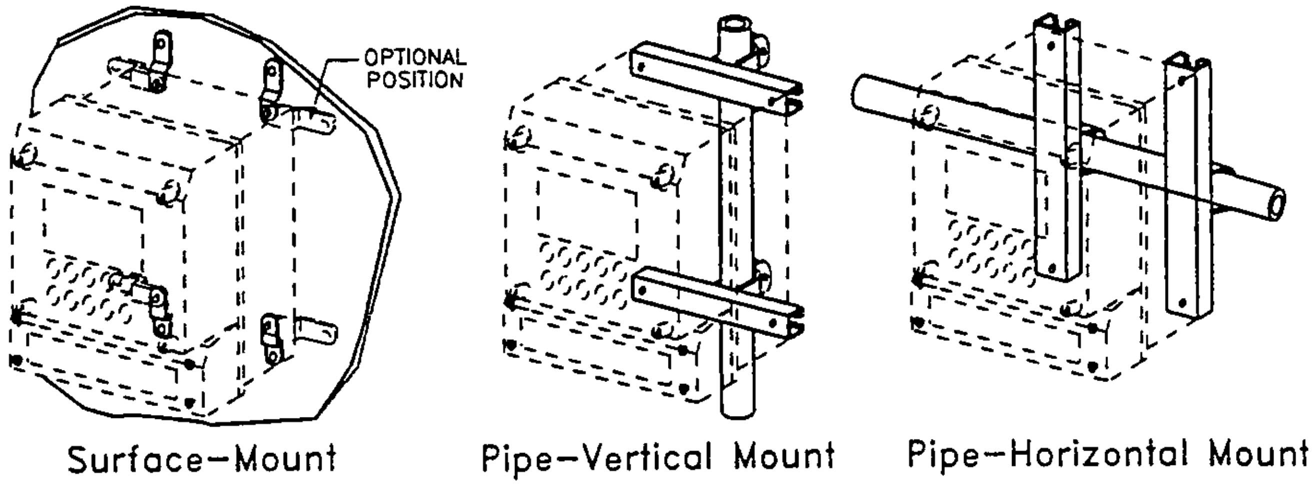


FIGURE 2-2 Mounting Configurations

2.3 Plugging Conduit Holes

Use conduit hubs or cable feed-thru fittings where cables enter the enclosure. Holes not used for cable entry should be sealed with plugs.

NOTE: Use NEMA 4 rated fittings and plugs to maintain the watertight integrity of the NEMA 4 enclosure.

SECTION 3 - ELECTRICAL CONNECTIONS

To access terminal strips for electrical connections, loosen bottom four captive fasteners and remove terminal compartment cover. Figure 3-2 on page 23 shows terminal designations for instrument hook-up.

3.1 GLI 5-Wire Differential Technique Sensor

It is recommended that sensor signal wires be run in 1/2" metal conduit for protection against moisture and mechanical damage. Do not run signal wires in same conduit with power or control wiring ("electrical noise" may interfere with sensor signal).

1. Place **SWITCH 3** on back of display module assembly (Figure 3-2) in **DIFF.** (off/right) position and **TEMP. COMP.** switch to **THERM.**
2. Connect sensor (or interconnect cable) wires to DIFFERENTIAL SENSOR terminals on TB2 (Figure 3-2), matching colors as indicated.

3.2 Conventional pH Combination Electrode

Direct Hook-up (For Distances Less Than 10 Feet)

1. Place **SWITCH 3** on back of display module assembly (Figure 3-2) in **COMB.** (on/left) position.

2. Active Electrode

   Connect active electrode (center wire in coaxial or triaxial cable) to TB5 (ACTIVE) terminal post.

3. Reference Electrode

   For a combination electrode that has a coaxial cable, clamp the braided shield (reference electrode wire) under TB4 (REF.) terminal as shown in Figure 2-3.

   If the electrode has a triaxial cable, clamp the inner braided shield (reference electrode wire) under TB4 (REF.) terminal as shown in Figure 2-4.

4. Temperature Compensation Wiring

   A. Automatic—With Integral Temperature Sensor

      1. The integral temperature sensor must be a 300 ohm thermistor or 1000 ohm RTD. Depending which type of sensor it is, set **TEMP.COMP.** switch to **THERM.** or **RTD.** position respectively.

      2. For a combination electrode that has a coaxial cable, connect separate temperature sensor wires (red and black for GLI industrial combination sensors) to TEMP COMP terminals on TB6 (Fig. 3-2).

         If the electrode has a triaxial cable, clamp the outer braided shield (temperature sensor wire) under TB3 (RTD) terminal as shown in Figure 2-4. In this case, set **TEMP.COMP.** switch to **RTD** position.

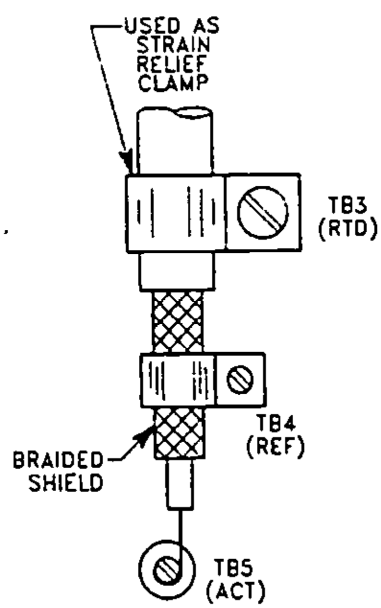


FIGURE 2-3
Connection Details For Combination Electrode With Coaxial Cable

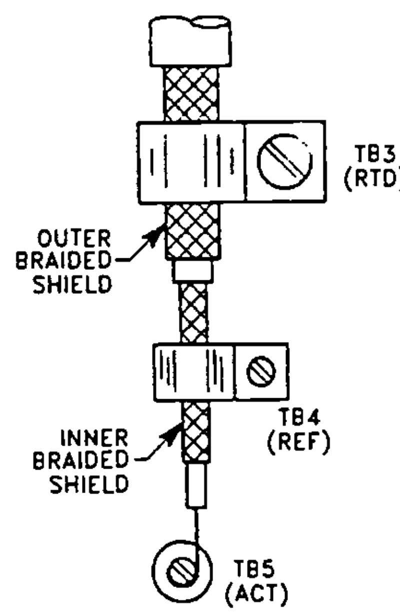


FIGURE 2-4
Connection Details For Combination Electrode With Triaxial Cable

B. Automatic—With Separate Temperature Sensor

1. The separate temperature sensor must be a 300 ohm thermistor or 1000 ohm RTD. Depending on which type of sensor it is, set **TEMP.COMP.** switch to **THERM.** or **RTD.** position respectively.

2. Connect separate temperature sensor (GLI p/n 60A2A9860-series) wires to TEMP COMP terminals on TB6 (Figure 3-2).

C. Fixed—With External Resistor

1. Set **TEMP.COMP.** switch to **THERM.** position.

2. Connect the specific value resistor which corresponds with the desired temperature compensation across TEMP COMP terminals on TB6 (Fig. 3-2). The following table provides specific resistor values required for the listed fixed temperature compensation.

Table A – RESISTOR VALUES FOR FIXED TEMPERATURE COMPENSATION

°C	Resistor Value (in ohms)	°C	Resistor Value (in ohms)
0	771	55	114
5	631	60	99
10	519	65	85
15	430	70	74
20	358	75	65
25	300	80	57
30	252	85	50
35	213	90	44
40	181	95	39
45	155	100	35
50	133		

Indirect Hook-up With Model 714 Preamp (For Distances More Than 10 Feet)

1. Place **SWITCH 3** on back of display module assembly (Figure 3-2) in **DIFF.** (off/right) position and **TEMP. COMP.** switch to **THERM.**

2. Locate the GLI Model 714 preamp within 10 feet of the combination electrode. Refer to the Model 714 preamp instruction manual for electrical connection details between the combination electrode and the preamp.

3. The Model 692P can be located up to 3000 feet from the Model 714 preamp. Connect interconnect cable from the preamp to the Model 692P DIFFERENTIAL SENSOR terminals on TB2 (Figure 3-2), matching colors as indicated.

685 245

3.3 Power Supply

Connect the DC voltage power supply to "4-20 mA" terminals on TB1, matching polarity as indicated.

NOTE: *If the 692P is used in an intrinsically safe application, it may be located in a Class I or II, Division 1 hazardous area without an explosionproof enclosure when powered through a suitable barrier. Refer to Section 3.5 for details on hazardous area wiring requirements.*

3.4 Analog Output

The isolated 4-20 mA output can represent either the measuring scale or a selected segment of it. To use the range expand feature, refer to Part Three, Section 3.4 for details.

The isolated 4-20 mA output can drive auxiliary devices (resistive loads) such as displays, recorders and computers, provided that the voltage supplied by the power supply is adequate. Devices must be wired <u>in series</u> with the transmitter and power supply. The voltage drop across the load(s) and the 16 volts DC minimum needed to drive the transmitter determines the minimum voltage required from the power supply.

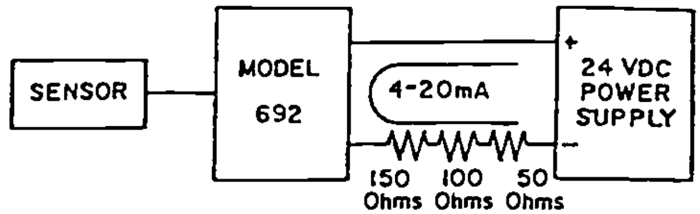
1. Determine the necessary voltage required to adequately drive the Model 692P and auxiliary device(s).

   A. The Model 692P acts as a current controlling device. Thus, the current output remains the same even if the power supply voltage fluctuates or the load resistance changes. The current varies only with respect to the sensor signal, as long as the voltage drop across the transmitter is at least 16 VDC, but not more than 40 VDC.

   B. The load(s) in the circuit will generally have some electrical resistance, 100 ohms for example. The 4-20 mA loop current will produce a voltage drop across each load. The maximum voltage drop will exist when the loop current is 20 mA. The power supply must provide enough voltage for this drop plus the 16 VDC minimum required for the Model 692P. Two examples illustrate this point:

EXAMPLE 1

Sufficient Power Supply Voltage



Total Load Resistance = 300 ohms

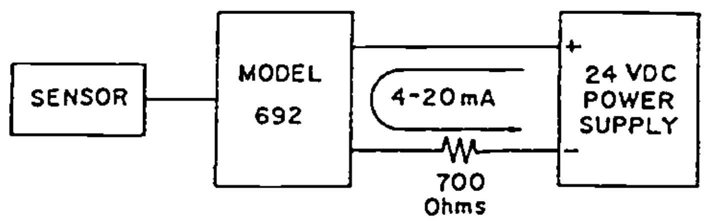
At 20 mA loop current, the voltage drop across the load(s) is 6 volts:

300 ohms x 20 mA = 6,000 mV or 6 volts

Subtract 6 volts from the 24 volt source to determine that 18 volts is available to power the Model 692. The 18 volts is within the specified 16 to 40 volt range and is sufficient to power the transmitter.

EXAMPLE 2

Insufficient Power Supply Voltage



Total Load Resistance = 700 ohms

At 20 mA loop current, the voltage drop across the load is 14 volts:

700 ohms x 20 mA = 14,000 mV or 14 volts

Subtract 14 volts from the 24 volt source to determine that 10 volts is available to power the Model 692. The 10 volts is below the specified 16 to 40 volt range and is not adequate to power the transmitter. If, for example, the power supply voltage was 40 volts instead of 24 volts, the voltage available to power the Model 692 would be 26 volts, well within the specified range.

2. Connect load(s) in series with transmitter and power supply.

NOTE: *Connecting the transmitter output to some types of computers may cause the computer display reading to fluctuate. This is caused by "electrical noise" in the signal line. To correct this condition, connect a 4.7 microfarad/80 volt, metal foil capacitor across the computer input.*

3.5 Hazardous Area Wiring

GLI recommends one of two intrinsic safety barriers for hazardous area wiring. GLI p/n 99X1F1053 is best suited for applications requiring shorter cable lengths (125 ft. max. on hazardous area side and 250 ft. max. on safe area side). For longer cable lengths (up to 3000 ft. on hazardous area side and 6000 ft. on safe area side), use barrier p/n 99X1F1054. Both barriers are certified by FM and CSA.

Follow the barrier manufacturer's general instructions and refer to Figure 2-5 for a basic connection diagram.

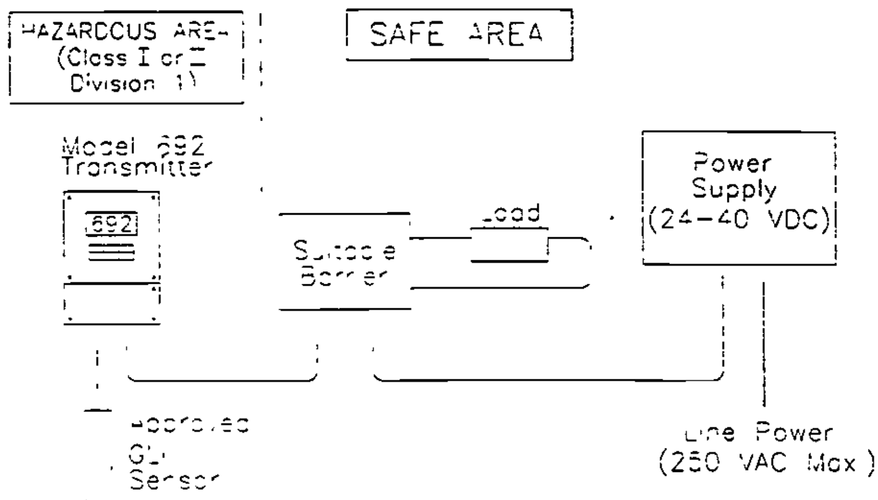


FIGURE 2-5 Hazardous Area Wiring -- Basic Connection Diagram

PART THREE - OPERATION

SECTION 1 - OPERATING CONTROLS

The frequently used keypad switches (Figure 3-1) can be used without opening the instrument enclosure. Seldom used setup controls are located on the backside of the display module assembly (Figure 3-2). They are accessed by loosening the upper four screw-type fasteners and opening the enclosure door. The complete door/display module assembly can be easily removed from the enclosure by unsnapping it from its hinge and disconnecting the ribbon-cable connector.

WARNING: DO NOT ADJUST THE FACTORY-SEALED (RED SEALANT) POTENTIOMETERS. IF SEALS ARE BROKEN, THE INSTRUMENT WARRANTY IS VOIDED. IF THE INSTRUMENT IS RETURNED TO GLI AND ANY OF THE FACTORY-SEALED POTENTIOMETERS REQUIRES A RE-ADJUSTMENT, A FACTORY SETUP CHARGE WILL BE INCURRED.

All switches, status indicators and program jumpers used for instrument operation are described in this section. Familiarize yourself with each item before operating the instrument.

1.1 Keypad Switches

1. EXAM/CANCEL key (Figure 3-1)

   Selects the normal "measurement" display mode or an "examination" display mode. Successive key presses alternate the display between these two modes.

   - In measurement mode:

     Display shows measured variable selected with DISP VAR key: pH, temperature, the sensor's mV signal, or the 4-20 mA instrument output.

   - In "examination" mode:

     Display shows setup variables and their stored values. Setup data such as calibration values, low and high endpoints for range expand, etc. are called up in the sequence shown in Figure 3-3 by pressing the NEXT key (item 2). Values can be changed by using the ↑ and ← keys (items 3 and 4) and are entered by pressing the ENTER/CANCEL HOLD key (item 5). Any entry routine may be cancelled by pressing the EXAM/CANCEL key which also returns display to normal measurement mode.

`685 243

2. **NEXT** key (Figure 3-1)

   - With display in measurement mode:

     This key has no effect.

   - With display in "examination" mode:

     Scrolls display to show next setup variable with each press. Refer to Tables B, C and D in Section 3 for a complete listing of all setup variables.

3. ⬆ key (Figure 3-1)

   - With display in measurement mode:

     This key has no effect.

   - With display in "examination" mode:

     Increases flashing digit value by one with each key press or continually advances digit value from 0 thru 9 by holding key down. This key is used with ⬅ key (item 4) to change displayed value to a new value.

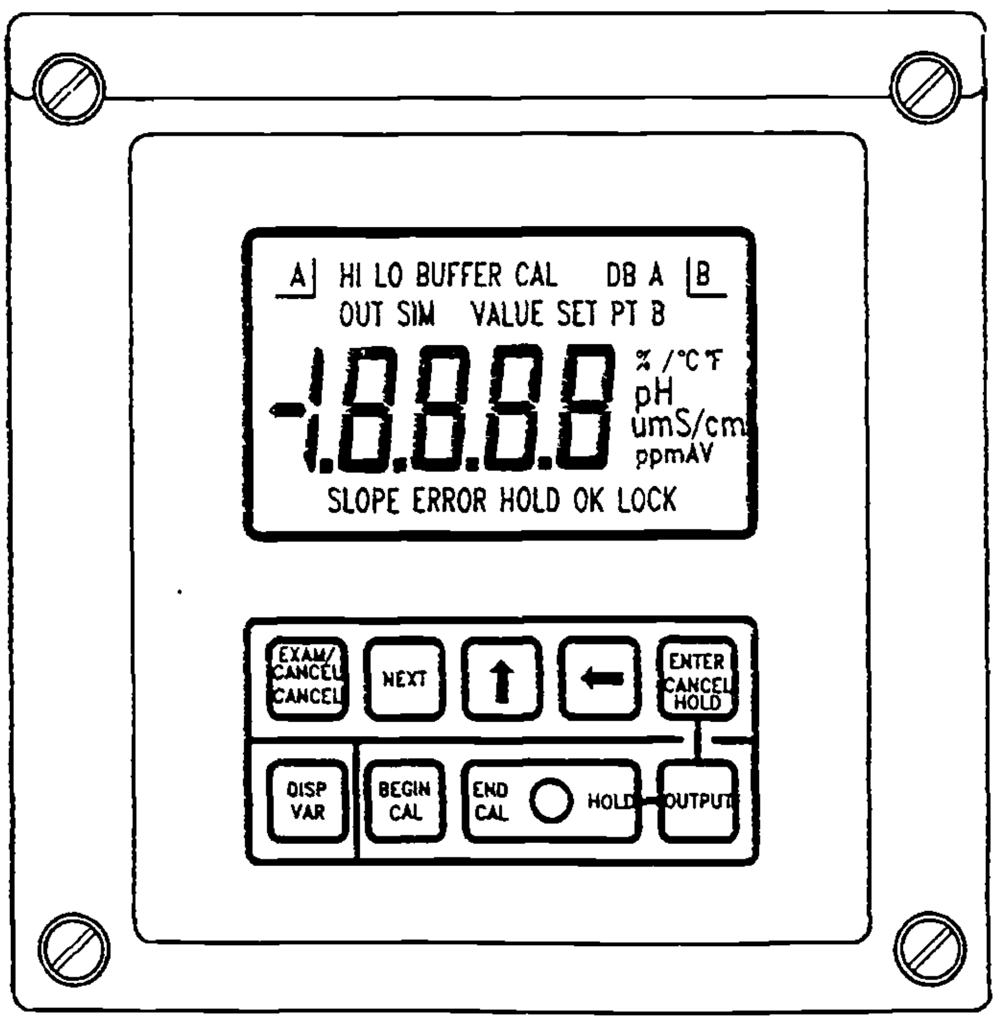


FIGURE 3-1 Keypad Switches

4. ← key (Figure 3-1)

   - With display in measurement mode:

     This key has no effect.

   - With display in "examination" mode:

     Progressively selects the next digit to the left to flash with each press-and-release so that its value can be changed with the ↑ key (item 3). The flashing digit "wraps around" from far left to far right.

5. **ENTER/CANCEL HOLD** key (Figure 3-1)

   - With display in measurement mode:

     Cancels output hold feature when pressed together with **OUTPUT** key (item 9).

   - With display in "examination" mode:

     A. Enters displayed value into memory (if within acceptable range) for the indicated setup variable. Display flashes "OK" for approximately 5 seconds to confirm entry.

     B. Cancels output hold feature when pressed together with **OUTPUT** key (item 9).

6. **DISP VAR** key (Figure 3-1)

   - With display in measurement mode:

     Scrolls display with each key press to show the following measured variables: pH, temperature (°C or °F), the sensor's mV signal, and the 4-20 mA instrument output.

     NOTE: *As a display check, all indicators light up (as shown in Figure 3-1) when 4-20 mA output variable is displayed and **EXAM/CANCEL** key is pressed.*

   - With display in "examination" mode:

     This key has no effect.

7. **BEGIN CAL** key (Figure 3-1)

   - With display in measurement mode:

     A. Displays stored value for LO or HI CAL VALUE setup variable used in "two-key" calibration (two-point or table method). Each key press alternately displays both stored values. **EXAM/CANCEL** key must be pressed to return display to normal indication.

685 251

B. Initiates calibration of a point used in "two-key" calibration (two-point or table method). Specific buffer values should be stored in memory before using this key to initiate calibration (see Part Three, Section 6.4 or 6.5 for details).

- With display in "examination" mode:

  This key has no effect.

8. **END CAL/HOLD** recessed button (Figure 3-1)

- With display in measurement mode:

  Activates output hold feature when pressed together with **OUTPUT** key (item 9).

- With display in "examination" mode:

  A. Completes calibration of a point used in "two-key" two-point or "two-key" table method.

  B. Activates output hold feature when pressed together with **OUTPUT** key (item 9).

9. **OUTPUT** key (Figure 3-1)

With display in measurement or "examination" mode:

A. Activates output hold feature when pressed together with recessed **END CAL/HOLD** button.

B. Cancels output hold feature when pressed together with **ENTER/CANCEL HOLD** key.

1.2 Slide Switches

10. **SWITCH 2** (Figure 3-2)

Selects the state that the instrument will default to during an out-of-range condition due to a defective pH sensor or shorted sensor cable. The operator preselects a low or a high out-of-range default state. In case of failure, this prevents a pump or valve from operating, therefore conserving use of costly chemicals. For example, the process may typically be controlled between 7 and 8 pH with a tendency to increase without chemical addition. In this example, if an out-of-range condition occurs, chemical addition can be prevented by preselecting a low out-of-range default state. This causes the display to indicate 0 pH and provides the corresponding loop current (4 or 20 mA).

0 pH POSITION (on/left) - Selects low out-of-range default state. When defective pH sensor or shorted sensor cable

is detected, display will indicate 0 pH (and ERR 1 or ERR 3 diagnostic message) and a corresponding loop current (4 or 20 mA) will be provided.

14 pH POSITION (off/right) - Selects high out-of-range default state. When defective pH sensor or shorted sensor cable is detected, display will indicate 14 pH (and ERR 1 or ERR 3 diagnostic message) and a corresponding loop current (4 or 20 mA) will be provided.

11. **SWITCH 3** (Figure 3-2)

    COMB. POSITION (on/left) - Programs the instrument for use with a combination electrode.

    DIFF. POSITION (off/right) - Programs the instrument for use with a GLI 5-wire Differential Technique sensor.

12. **SWITCH 4** (Figure 3-2)

    °F POSITION (on/left) - Selects measured temperature to be displayed in °F.

    °C POSITION (off/right) - Selects measured temperature to be displayed in °C.

13. **TEMP. COMP.** switch (Figure 3-2)

    RTD - Programs instrument for use with a 1000 ohm RTD temperature sensor for automatic temperature compensation.

    THERM. - Programs instrument for use with a 300 ohm thermistor temperature sensor for automatic temperature compensation or a specific-valued resistor for fixed temperature compensation.

1.3 Program Jumper

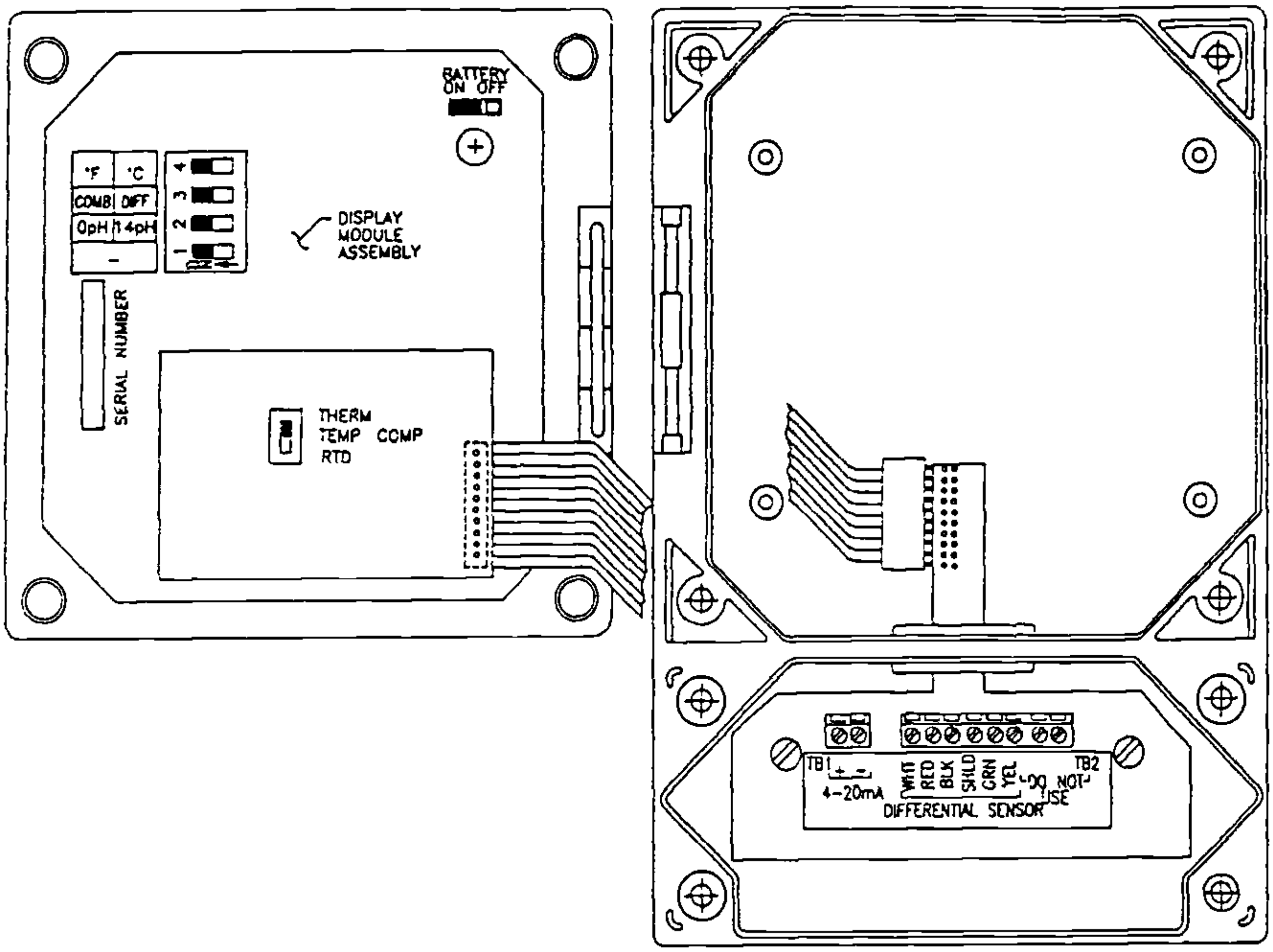
14. **BATTERY** jumper (Figure 3-2)

    ON - Connects battery to store user-entered setup variable values even when power is lost or turned off.

    OFF - Disconnects battery when instrument is not to be used for an extended time.

    CAUTION: Disconnecting the battery with power removed will cause loss of all stored, user-entered setup values.

685 253



TERMINAL COMPARTMENT
SHOWN WITH OPTIONAL
INPUT BOARD
(accepts combination electrode)

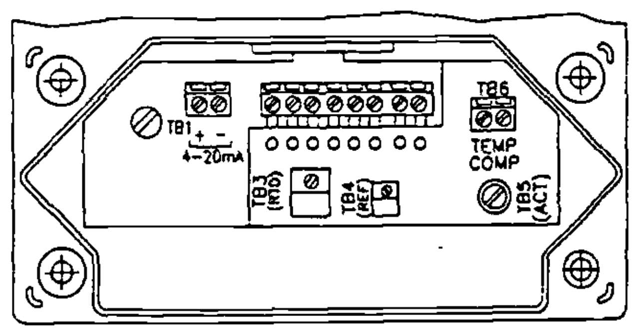


FIGURE 3-2 Controls On Backside Of Display Module Assembly And Electrical Hook-Up Details

1.4 Status Indicators

15. **HOLD** indicator (LCD display)

    Indicates that the output hold feature is in use (instrument output value is maintained).

    NOTE: *After 30 minutes,* ***HOLD*** *indicator flashes to indicate that output hold feature will be automatically cancelled in 30 seconds. Pressing* ***OUTPUT*** *key extends hold feature for another 30 minutes.*

16. **OK** indicator (LCD display)

    Flashes for approximately 5 seconds to confirm successful entry of a setup variable value.

17. **LOCK** indicator (LCD display)

    Indicates that instrument keypad entry is "locked" to prevent unauthorized alteration of stored setup variable values. Refer to Section 8 for security lock feature instructions.

    NOTE: *Calibration values can be entered and all stored values can be displayed when instrument is "locked".*

18. **ERROR** indicator (LCD display)

    Flashes to indicate an incorrect entry or alternately flashes with "Err 1", "Err 2", "Err 3" or "Err 4" to indicate a system diagnostic error causing improper system operation.

685 255

SECTION 2 - MEASURED VARIABLES

The 692P can display four measured variables. With the display in the measurement mode, each press of the **DISP VAR** key sequentially displays:

- pH.
- Temperature in °C or °F.
- The sensor's mV signal.
- The 4-20 mA instrument analog output.

SECTION 3 - SETUP VARIABLES

3.1 Calling Up Setup Variables

1. Pressing the **EXAM/CANCEL** key while the display is in the measurement mode changes the readout to an "examination" mode to show setup variables. The pH, temperature and mV displays each have a menu that contains related setup variables to configure the instrument.
2. Each press of the **NEXT** key displays the next setup variable, in sequence, for the respective menu. The setup variables "wrap around" from last to first within each menu.

The **EXAM/CANCEL** key may be pressed anytime to return the display to the measuring mode.

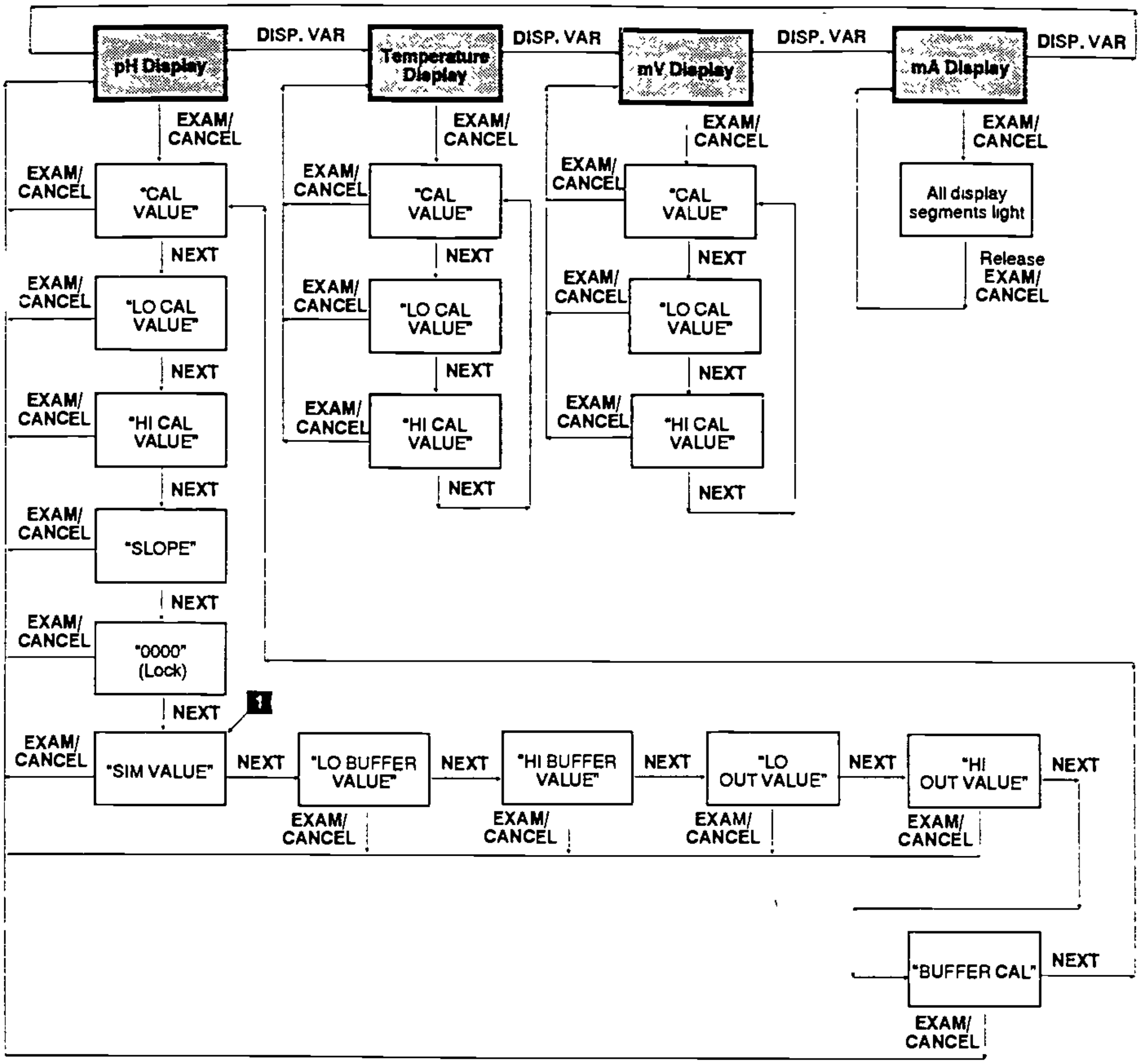
3.2 Entering Values

The ⬆ and ⬅ keys are used to change displayed setup values. Each press of the ⬆ key increases the flashing digit value by one. When held down, the ⬆ key continually advances the value. Pressing and releasing the ⬅ key selects the next digit to the left to flash, indicating that it can now be changed with the ⬆ key. After establishing the desired value, press the **ENTER** key to store it in memory. Thereafter, "OK" flashes for approximately 5 seconds to confirm that the entry was accepted or "ERROR" flashes if the entry was invalid.

3.3 Setup Variables Call-Up Chart And Table Of Descriptions

Figure 3-3 on the following page shows the four measured variable display modes (shaded boxes at top of chart), the related three menus of setup variables, and the call-up order of the setup variables within each menu. When the output hold feature is in use, the "SIM VALUE" setup variable is not displayed and cannot be used (see footnote at bottom of chart).

685 256



1 Displayed only when the output hold feature is not in use.

FIGURE 3-3 Display Modes And Call-up Chart Of Setup Variables

685 257

The following tables for each of the three setup variable menus list the setup variables in exact order of call-up, and describe their use, entry value range and factory default value. The far right column can be used to write in entered setup values for convenient referral.

Table B – DESCRIPTION OF pH SETUP VARIABLES					
Displayed Identifier	Use	Entry Value Range Min.	Entry Value Range Max.	Default Value	Record Your Entry ⬇
"CAL VALUE"	Sets calibration point for conventional single-point pH calibration.	0.00	14.00	7.00	
"LO CAL VALUE"	Sets low calibration point for conventional two-point pH calibration.	0.00	10.00	4.00	
"HI CAL VALUE"	Sets high calibration point for conventional two-point pH calibration.	2.00	12.00	10.00	
"SLOPE"	Display only of 0-100% slope (0-59mV/pH).	—	—	—	—
"0000"	Activates the security lock feature.	0000	9999	0000	—
"SIM VALUE"▲	Sets simulated pH value for diagnostic purposes. The analog output responds to the displayed value.	0.00	14.00	7.00	
"LO BUFFER VALUE"	Sets the value of lower buffer used for "two-key" pH calibration: Two-point method Table method	0.00 1.09	10.00 10 A	4.00 4.00	
"HI BUFFER VALUE"	Sets the value of higher buffer used for "two-key" pH calibration: Two-point method Table method	2.00 3.56	12.00 12.45	10.00 10 A	
"LO OUT VALUE"	Sets low endpoint of pH measuring range at which the minimum output (4 mA) is provided.	0.00	14.00	0.00	
"HI OUT VALUE"	Sets high endpoint of pH measuring range at which the maximum output (20 mA) is provided.	0.00	14.00	14.00	
"BUFFER CAL"	Selects two-point or table method for "two-key" pH calibration.	tABL	2 Pt	2 Pt	

▲Only provided and displayed when the output hold feature is not in use.

Table C – DESCRIPTION OF TEMPERATURE SETUP VARIABLES					
Displayed Identifier	Use	Entry Value Range Min.	Entry Value Range Max.	Default Value	Record Your Entry ⬇
"CAL VALUE"	Sets calibration point for single-point temperature calibration: °C °F	0.0 32.0	100.0 212.0	25.0 77.0	
"LO CAL VALUE"	Sets low calibration point for two-point temperature calibration: °C °F	0.0 32.0	30.0 86.0	0.0 32.0	
"HI CAL VALUE"	Sets high calibration point for two-point temperature calibration: °C °F	25.0 77.0	100.0 212.0	100.0 212.0	

685 258

Table D – DESCRIPTION OF mV SETUP VARIABLES					
Displayed Identifier	Use	Entry Value Range		Default Value	Record Your Entry
		Min.	Max.		
"CAL VALUE"	Sets calibration point for single-point millivolt calibration.	(–)500	(+)500	(+)200	
"LO CAL VALUE"	Sets low calibration point for two-point millivolt calibration.	(–)500	(+)50	(–)180	
"HI CAL VALUE"	Sets high calibration point for two-point millivolt calibration.	(+)100	(+)500	(+)180	

SECTION 4 - INSTRUMENT STARTUP

4.1 Checking Battery Back-up Jumper

An internal battery powers the memory which retains all user-entered setup variable values in the event power is lost. The 692P is supplied with its **BATTERY** jumper (Figure 3-2) in the **OFF** position. Make sure to place this jumper in the **ON** position before proceeding.

4.2 Programming For Type Of Sensor Input

The 692P must be programmed to accept the type of sensor input which will be used.

GLI 5-Wire Differential Technique Sensor

1. Locate the group of four switches on back of display module assembly (Figure 3-2) and place **SWITCH 3** in **DIFF.** (off/right) position.

2. Set **TEMP. COMP.** switch to **THERM** position.

# # #

Conventional pH Combination Electrode

1. Direct Hook-up (For Distances Less Than 10 Feet)

   A. Locate the group of four switches on back of display module assembly (Figure 3-2) and place **SWITCH 3** in **COMB.** (on/left) position.

   B. Depending on the type of temperature sensor used for temperature compensation, set **TEMP. COMP.** switch as follows:

      a. If a 1000 ohm RTD is used, place in **RTD** position.

      b. If a 300 ohm thermistor or a fixed resistor is used, place in **THERM** position.

2. Indirect Hook-up With Model 714 Preamp (For Distances Greater Than 10 Feet)

   A. Locate the group of four switches on back of display module assembly (Figure 3-2) and place **SWITCH 3** in **COMB.** (on/left) position.

   B. Set **TEMP. COMP.** switch to **THERM.** position.

685 253

4.3 Selecting Temperature Display Units (°C or °F)

Locate the group of four switches on back of display module assembly (Figure 3-2) and place **SWITCH 4** in **°F** (on/left) position for temperature values to be displayed in °F. Place in opposite **°C** (off/right) position for °C readout.

4.4 Initial Calibration

Before initially calibrating the instrument, read Section 5.1 "Temperature Effects On The pH Reading" and Section 6.1 "Summary Of Methods To Use". Then calibrate the instrument using the desired method.

4.5 Selecting Default State For Out-Of-Range Condition

When an out-of-range condition occurs due to a defective pH sensor or shorted sensor cable, the instrument will respond to the default state selected with **SWITCH 2** (Figure 3-2). Refer to Section 1.2 - item 10 for details about this switch and its settings.

SECTION 5 - TEMPERATURE CALIBRATION

5.1 Temperature Effects On The pH Reading

The instrument automatically compensates the pH reading for changes in temperature and has temperature calibration capabilities. For best accuracy, it is recommended to initially calibrate the instrument for temperature <u>before</u> performing pH calibration.

300 Ohm Thermistor Compensation

When using a GLI Differential Technique pH sensor or a pH combination electrode with a 300 ohm thermistor, temperature calibration can be bypassed (the 692P is factory-calibrated for this temperature sensor). However, if extremely accurate temperature measurement is required, a single or two-point temperature calibration may be performed (Section 5.2 or 5.3) <u>before</u> calibrating the 692P for pH.

1000 Ohm RTD Compensation

When using a pH combination electrode with a 1000 ohm RTD, a two-point temperature calibration should be performed <u>before</u> pH calibration to obtain the most accurate pH readings.

Fixed Resistor Compensation

When using a pH combination electrode with an external resistor for fixed temperature compensation, a single-point temperature calibration should be performed to provide the best pH measurement accuracy. Instead of normally entering the known temperature value of a solution, enter the temperature compensation value (in °C) that corresponds with the value of the external resistor being used (see Table A on page 14).

5.2 Single-Point Method

This method requires a container of water (or process solution) that has a known temperature value approximately equal to the normal operating temperature of the process.

1. Place temperature sensor in water (or process solution) of known temperature value.

2. Press **DISP VAR** key as needed to display temperature and allow display reading to stabilize. The sensor may take several minutes to attain temperature equilibrium with the solution.

3. Press **EXAM/CANCEL** key to place display in "examination" mode and to indicate temperature "CAL VALUE".

4. Use ⬅ and ⬆ keys to make display indicate the known temperature value of the solution.

5. Press **ENTER** key to enter value (display flashes "OK" to confirm entry and returns to temperature measuring mode). "HI/LO ERROR" flashes if the difference between the entry value and actual solution temperature is greater than 5.0°C.

This completes the single-point temperature calibration.

5.3 Two-Point Method

This method requires a container of ice water and a container of water (or process solution) that has a known temperature value of 90-100°C (194-212°F) or is approximately equal to the normal operating temperature of the process.

1. Place temperature sensor in ice water.

2. Press **DISP VAR** key as needed to display temperature and allow display reading to stabilize. The sensor may take several minutes to attain temperature equilibrium with the solution.

3. Press **EXAM/CANCEL** key to place display in "examination" mode.

4. Press **NEXT** key <u>once</u> to make display indicate temperature "LO CAL VALUE".

5. Use ⬅ and ⬆ keys to make display indicate "0.0°C" or ("32.0°F").

6. Press **ENTER** key to enter value (display flashes "OK" to confirm entry and returns to temperature measuring mode). If "HI/LO ERROR" flashes, the difference between the entry value and actual solution temperature is greater than 10.0°C.

7. Place temperature sensor in the known higher temperature water (or process solution). Allow sensor to attain temperature equilibrium with the solution.

8. Press **EXAM/CANCEL** key to place display in "examination" mode.

9. Press **NEXT** key <u>twice</u> to make display indicate temperature "HI CAL VALUE".

685 261

10. Use ⬅ and ⬆ keys to make display indicate the known temperature value.

    NOTE: Entry value must be between 25.0 and 100.0°C and at least 10.0°C higher than the lower calibration point (0.0°C from step 5).

11. Press **ENTER** key to enter value (display flashes "OK" to confirm entry and returns to temperature measuring mode). "VALUE ERROR" flashes if the difference between entry values is less than 10.0°C. If "HI/LO ERROR" flashes, entry value is out of range (less than 25.0°C or greater than 100.0°C) or the difference between the entry value and actual solution temperature is greater than 10.0°C.

This completes the two-point temperature calibration.

SECTION 6 - pH CALIBRATION

The instrument must be calibrated periodically with pH buffer solution(s) to maintain measurement accuracy. It is highly recommended to establish a maintenance program to keep the sensor clean and the instrument calibrated. The time period between performing maintenance (days, weeks, etc.) is affected by the characteristics of the process solution and can only be determined by operating experience. For example, a sensor operating in wastewater that contains oil and/or grease may require more frequent cleaning.

6.1 Summary Of Methods To Use

The instrument can be calibrated for pH in a number of different ways. Conventional single and two-point methods (Sections 6.2 and 6.3) can be used where the operator enters the buffer values into memory.

NOTE: The conventional two-point method is highly recommended for initial calibration or when the pH sensor has been replaced.

Two alternate "two-key" calibration methods are also possible which are especially convenient for the novice operator because they eliminate the need for that person to enter buffer values. When the "two-key" two-point calibration method (Section 6.4) is used, two buffer values are first entered by a qualified person. Anytime thereafter, a novice operator can accurately calibrate the instrument for each point by simply pressing two keys. The only operator requirement is that the sensor must be in the appropriate buffer for each calibration point.

The other "two-key" calibration method is the <u>table method</u> (Section 6.5). It's similar to the "two-key" two-point method except that the buffer values, and their related pH versus temperature curves, are selected from a table of 14 specific buffer formulations. This method provides the most accurate calibration because errors caused by small changes of the buffer value due to temperature variations are eliminated. During calibration, the instrument can automatically recognize and differentiate between the two buffers preselected from the table. The operator need not know the buffer values.

6.2 Conventional Single-Point Method

This procedure requires a clean sensor and one fresh, accurate pH buffer with a value reasonably close to the normal pH of the process (pH 7, 4 or 10 buffer is recommended and readily available).

1. With display in pH measuring mode, place *clean* sensor, with protective caps removed, in the known buffer. Allow display reading to stabilize. The sensor may take several minutes to attain temperature equilibrium with the buffer.

   NOTE: *If a pH combination electrode is used with an <u>external</u> temperature sensor, place the temperature sensor in the buffer along with the electrode. If an external resistor is used for fixed temperature compensation (Table A on page 14), it is recommended for best accuracy to bring the temperature of the buffer to that specific temperature.*

2. Press **EXAM/CANCEL** key to place display in "examination" mode and to indicate pH "CAL VALUE".
3. Use ← and ↑ keys to make display indicate the known pH value of the buffer (from table on buffer bottle).
4. Press **ENTER** key to enter value (display flashes "OK" to confirm entry and returns to pH measuring mode).

This completes the conventional single-point pH calibration.

6.3 Conventional Two-Point Method

This procedure requires a clean sensor and two fresh, accurate pH buffers. pH 7 and pH 4 buffers are recommended and are readily available. If pH 4 buffer is not available, pH 10 buffer may be substituted.

1. With display in pH measuring mode, place *clean* sensor, with protective caps removed, in the <u>lower</u> value buffer. Allow display reading to stabilize. The sensor may take several minutes to attain temperature equilibrium with the buffer.

685 263

NOTE: If a pH combination electrode is used with an external temperature sensor, place the temperature sensor in the buffer along with the electrode during this step and step 6. If an external resistor is used for fixed temperature compensation (Table A on page 14), it is recommended for best accuracy to bring the temperature of buffer used in this step and step 6 to the fixed compensation temperature.

2. Press **EXAM/CANCEL** key to place display in "examination" mode.
3. Press **NEXT** key once to make display indicate pH "LO CAL VALUE".
4. Use ⬅ and ⬆ keys to make display indicate the value of the lower pH buffer (from table on buffer bottle).

   NOTE: Entry value must be between 0.00 and 10.00 pH and at least 1.00 pH lower than the value of the higher calibration point.

5. Press ENTER key to enter value (display flashes "OK" to confirm entry and returns to pH measuring mode).

   NOTE: If display indicates "Err 1" diagnostic message, ignore it and proceed with step 6. This message indicates that the new LO CAL VALUE entry is significantly different than the previously entered calibration values. After the HI CAL VALUE is entered (step 10), the "Err 1" message should be cancelled and the display returned to normal indication.

6. Remove sensor from lower value buffer. Rinse sensor in clean water and place in higher value buffer. Allow sensor to attain temperature equilibrium with the buffer.
7. Press **EXAM/CANCEL** key to place display in "examination" mode.
8. Press **NEXT** key twice to make display indicate pH "HI CAL VALUE".
9. Use ⬅ and ⬆ keys to make display indicate the value of the higher pH buffer (from table on buffer bottle).

   NOTE: Entry value must be between 2.00 and 12.00 pH and at least 1.00 pH higher than the value of the lower calibration point.

10. Press ENTER key to enter value (display flashes "OK" to confirm entry and returns to pH measuring mode). "VALUE

685· 2C4

ERROR" flashes if the difference between entry values is less than 1.00 pH.

This completes the conventional two-point pH calibration.

6.4 "Two-Key" Two-Point Method

For initial calibration, or if the pH sensor has been replaced, the instrument should first be calibrated using the conventional two-point method (Section 6.3). Thereafter, the "two-key" two-point method may be used, but first a qualified person must:

- Program the instrument for this method.
- Enter pH buffer (or known process solution) values to be used as the two calibration points.

Thereafter, the instrument can be periodically calibrated using the procedure described under the "Performing Calibration" subheading.

Programming 692P For This Method

1. With display in pH measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "BUFFER CAL".
3. Press ← key to make display indicate "2 Pt".
4. Press **ENTER** key to select "two-key" two-point method ("OK" flashes to confirm entry).

# # #

Entering Calibration Points (By Qualified Person)

1. Press **NEXT** key until display indicates "LO BUFFER VALUE".
2. Use ← and ↑ keys to make display indicate the desired value for the lower calibration point.

   NOTE: *Entry value must be 10.00 pH or lower.*

3. Press **ENTER** key to enter value ("OK" flashes to confirm entry).
4. Press **NEXT** key once to make display indicate "HI BUFFER VALUE".
5. Use ← and ↑ keys to make display indicate the desired value for the higher calibration point.

   NOTE: *Entry value must be at least 2.00 pH units higher than the value of the lower calibration point.*

6. Press **ENTER** key to enter value (display flashes "OK" to confirm entry or "VALUE ERROR" if difference between entry value and LO BUFFER VALUE is less than 2.00 pH units).

685 265

7. Press **EXAM/CANCEL** key to return display to pH measuring mode.

Performing Calibration

Use this "two-key" two-point method to calibrate the instrument after both calibration points have been entered. This calibration procedure requires a clean sensor and two fresh, accurate pH buffers (or known process solutions) that have the same values as the two preselected calibration points.

1. Place *clean* sensor, with protective caps removed, **in the lower value buffer.**

   NOTE: If a pH combination electrode is used with an external temperature sensor, place the temperature sensor in the buffer along with the electrode during this step and step 4. If an external resistor is used for fixed temperature compensation (Table A on page 14), it is recommended for best accuracy to bring the temperature of buffer used in this step and step 4 to the fixed compensation temperature.

2. With display in pH measuring mode, press **BEGIN CAL** key (display indicates one of the preset values – "LO CAL VALUE" or "HI CAL VALUE"). If display indicates the higher value, press **BEGIN CAL** key again to display lower value.

   When **BEGIN CAL** is pressed, the operator has 30 minutes to complete the calibration of this point. During the routine, pressing any key except **END CAL** provides another 30 minutes if needed.

   The instrument checks the stability of the pH and temperature inputs. As each input changes, the respective pH and °C (or °F) indicator flashes. When each input is stable, the respective indicator stops flashing and remains on.

3. When the pH and °C (or °F) indicators are both on (not flashing), press recessed **END CAL** button using a slender tool. The instrument checks that:

   - The pH input has a slope between 51 and 62 mV/pH. If not, the display flashes "HI/LO SLOPE ERROR".
   - The pH input offset is within ±1.50 pH of the entry value. If not, the display flashes "HI/LO ERROR".
   - This calibration point is at least 2.00 pH away from the other calibration point. If not, the display flashes "BUFFER VALUE ERROR".

   When these conditions are met, the display flashes "OK" to confirm entry was made and returns to the pH measuring mode.

NOTE: *If display flashes "HI/LO SLOPE ERROR" or "HI/LO ERROR", an incorrect buffer value may have been used or the sensor may be dirty or defective. If the correct buffer value was used, calibrate the instrument using the conventional two-point method (Section 6.3) to check the sensor slope which is based on the last successful calibration. Refer to Part Four, Section 1.3 for details on checking sensor slope.*

4. Remove sensor from lower value buffer. Rinse sensor in clean water and place **in the higher value buffer.**
5. Press **BEGIN CAL** key to initiate calibration of the second calibration point.
6. When the pH and °C (or °F) indicators are both on (not flashing), press recessed **END CAL** button using a slender tool. See step 3 for additional details.

This completes the "two-key" two-point pH calibration.

6.5 "Two-Key" Table Method

Any buffer has some variation of pH value with temperature, but few operators take the time to measure the buffer temperature with the sensor at equilibrium, and then enter the pH of the buffer at that temperature. The concept of this "two-key" table method is that the 692P has the built-in pH value versus temperature curve for a set of buffers and monitors the temperature and time response when the sensor is put into a buffer. Using this method provides the most accurate calibration.

For initial calibration, or if the pH sensor has been replaced, the instrument should first be calibrated using the conventional two-point method (Section 6.3). Thereafter, the "two-key" table method may be used, but first a qualified person must:

- Program the instrument for this method.
- Select and enter one or two pH buffer values from the buffer table to be used as the calibration point(s).

Thereafter, the instrument can be periodically calibrated using the procedure described under the "Performing Calibration" subheading beginning on page 38.

Programming 692P For This Method

1. With display in pH measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "BUFFER CAL".

685 267

3. Press ⬅ key to make display indicate "tAbL".

4. Press **ENTER** key to select "two-key" table method ("OK" flashes to confirm entry).

\# \# \#

Entering Calibration Points (By Qualified Person)

1. The following table lists the selection of pH values and their buffer formulations. Choose and note one or two table pH values for use as the calibration point(s).

NOTE: *When two calibration point values are selected, they must be at least one table value apart from each other (non-adjacent values).*

Table E – BUFFER VALUES FOR "TWO-KEY" TABLE METHOD

pH Buffer Value	Buffer Formulation
1.09	HCl (DIN 19267)
1.68	Tetraoxalate (NBS 260-53)
3.56	Tartrate (NBS 260-53)
3.78	Citric acid (DIN 19266)
4.00*	Pthalate (DIN 19266)
4.01	Pthalate (NBS 260-53)
4.65	Acetate (DIN 19267)
6.87	Phosphate (DIN 19266)
7.00	Phosphate
7.41	Phosphate (DIN 19266)
9.18	Borax (NBS 260-53)
10.00 (10 A on display)*	Carbonate/bicarbonate (0.5 Molar)
10.00 (10 b on display)	Glycol
12.45	Calcium hydroxide (DIN 19266)

*Indicates default values for LO and HI BUFFER VALUES.

2. Press **NEXT** key until display indicates "LO BUFFER VALUE".

3. Use ⬅ and ⬆ keys to make display indicate the desired value for the single or lower calibration point.

NOTE: *If desired LO BUFFER VALUE is equal to or higher than the current HI BUFFER VALUE, change the HI BUFFER VALUE first (step 5) before entering the LO BUFFER VALUE.*

4. Press **ENTER** key to enter value ("OK" flashes to confirm entry).

5. If a second calibration point is used (or if single calibration point cannot be accessed using LO BUFFER VALUE):

   A. Press **NEXT** key <u>once</u> to make display indicate "HI

BUFFER VALUE".

B. Use ← or ↑ key to make display indicate the desired value for the calibration point (see Table E).

NOTE: *If desired HI BUFFER VALUE is equal to or lower than the current LO BUFFER VALUE, change the LO BUFFER VALUE first before entering the HI BUFFER VALUE.*

C. Press **ENTER** key to enter value ("OK" flashes to confirm entry).

6. Press **EXAM/CANCEL** key to return display to pH measuring mode.

Performing Calibration

For best accuracy, be sure to use buffer values of the same formulation as those selected from Table E. To verify buffers, refer to Part Four, Section 1.6 for the pH vs. temperature data of all Table E buffer formulations.

Use this "two-key" table method to calibrate the instrument after calibration point(s) have been entered. This calibration procedure requires a clean sensor and fresh, accurate pH buffer(s) that have the same value(s) as the preselected calibration point(s).

1. Place *clean* sensor, with protective caps removed, in one of the calibration buffers. The operator need not know which buffer it is, but it must be one of the entered buffers selected from the table.

2. With display in pH measuring mode, press BEGIN CAL key.

   The operator has 30 minutes to complete the calibration of this point. During the routine, pressing any key except END CAL provides another 30 minutes if needed.

   The instrument checks:

   - The stability of the pH and temperature inputs. As each input changes, the respective pH and °C (or °F) indicator flashes. When each input is stable, the respective indicator stops flashing and remains on.

   - That the pH input is within ±0.75 pH of the buffer value. When outside this range, the display flashes "OUT"; within this range the "OUT" indicator goes off.

   When these conditions are met, the display will indicate "LO CAL VALUE" or "HI CAL VALUE", depending on which buffer the sensor is in.

685 269

3. When display indicates "LO CAL VALUE" or "HI CAL VALUE" and the pH and °C (or °F) indicators are both on (not flashing), press recessed **END CAL** button using a slender tool. The displayed identifier and value goes off, "OK" flashes for 5 seconds to confirm entry and the display returns to the pH measuring mode.
4. If a second calibration point is used, remove sensor from first buffer. Rinse sensor in clean water and place in the second buffer.
5. With display in pH measuring mode, press **BEGIN CAL** key. See step 2 for additional details.
6. Perform step 3.

This completes the "two-key" table pH calibration.

SECTION 7 - OUTPUT SETUP

7.1 Using Range Expand Feature

The isolated 4-20 mA analog output can represent the entire pH measuring scale or a desired segment of it. The LO OUT VALUE and HI OUT VALUE setup variables are used to enter low and high endpoints of the segment at which 4 mA and 20 mA is desired. Note these important points:

- The desired segment, represented by the 4-20 mA output, cannot be smaller than 1.00 pH unit.
- When the measured pH is below or above the selected segment, the 4-20 mA output is limited to 4 mA or 20 mA respectively.

The procedure to use the range expand feature is described with the following example.

RANGE EXPAND SETUP EXAMPLE
Suppose the 4-20 mA output is desired between 5.00 and 10.00 pH.

Setting The Low Endpoint

The low endpoint, entered with the LO OUT VALUE setup variable, is the point at which the minimum output (4 mA) is provided.

1. With display in pH measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "LO OUT VALUE".

3. Use ← and ↑ keys to make display indicate the low endpoint at which 4 mA is to be provided (5.00 pH for this example).

   NOTE: *Entry value must be at least 1.00 pH unit away from any previously entered HI OUT VALUE.*

4. Press **ENTER** key to enter value (display flashes "OK" to confirm entry or "VALUE ERROR" if difference between entry value and HI OUT VALUE is less than 1.00 pH unit).

Setting The High Endpoint

The high endpoint, entered with the HI OUT VALUE setup variable, is the point at which the maximum output (20 mA) is provided.

1. With the display still in "examination" mode, press **NEXT** key once to make display indicate "HI OUT VALUE".

2. Use ← and ↑ keys to make display indicate the high endpoint at which 20 mA is to be provided (10.00 pH for this example).

   NOTE: *Entry value must be at least 1.00 pH unit away from LO OUT VALUE.*

3. Press **ENTER** key to enter value (display flashes "OK" to confirm entry or "VALUE ERROR" if difference between entry value and LO OUT VALUE is less than 1.00 pH unit).

7.2 Using Output Hold Feature

The isolated 4-20 mA analog output can be held during calibration or while setting up the instrument to suspend operation of a receiving device.

When pressed simultaneously, the **OUTPUT** key and recessed **END CAL/HOLD** button activate the hold mode feature. At this time, the **HOLD** status indicator lights and the output value is held for 30 minutes unless the hold feature is extended or cancelled. Thirty seconds before the 30-minute hold period expires, the **HOLD** indicator begins flashing to warn of impending automatic cancellation. Another press of the **OUTPUT** key extends the hold period for another 30 minutes. The output hold feature may be cancelled at any time by simultaneously pressing the **CANCEL HOLD** and **OUTPUT** keys.

SECTION 8 - USING SECURITY LOCK FEATURE

A security lock feature is provided to prevent unauthorized alteration of stored values. When the 692P is locked (identified with lit **LOCK** status indicator), stored setup variable values—including preset calibration points for both "two-key" methods—cannot be changed. However, calibration can be per-

685 271

formed using any method and all stored values can be displayed.

8.1 Locking Stored Values

1. With display in pH measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "SLOPE". Then press **NEXT** key once more to display "0000" (identifier for security lock feature).
3. Use ⬆ key to make display indicate the lock code "0001".
4. Press **ENTER** key to enter lock code (**LOCK** status indicator lights and display flashes "OK" to confirm code entry).
5. Press **EXAM/CANCEL** key to return display to pH measuring mode.

# # #

8.2 Unlocking Stored Values

1. With display in pH measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "SLOPE". Then press **NEXT** key once more to display "0000" with **LOCK** status indicator lit (identifiers for security lock feature).
3. Use ⬅ and ⬆ keys to make display indicate the unlock code "1234".
4. Press **ENTER** key to enter unlock code (**LOCK** status indicator turns off and display flashes "OK" to confirm code entry).
5. Press **EXAM/CANCEL** key to return display to pH measuring mode.

PART FOUR - OPERATING AIDS

SECTION 1 - PRESERVING MEASUREMENT ACCURACY

1.1 Keeping Sensor Clean

Clean the sensor as required using the recommended procedure described in the sensor operating instruction manual.

1.2 Keeping Instrument Calibrated

Calibrate the instrument as experience dictates, using one of the methods described in Part Three, Section 6. Errors in readings may be caused by using a diluted or contaminated pH buffer solution when calibrating the instrument. For best accuracy, do not reuse buffers. The system can never be more accurate than the buffers used to calibrate it. Note that buffer solutions may change in value with ambient temperature. Therefore, the sensor and buffer solution should be allowed to come to the same temperature and the value of the buffer at that temperature, should be known.

1.3 Checking Sensor Slope

The "slope" of a pH sensor is an indicator of its performance. pH sensor slope can be displayed with the SLOPE function after completing any two-point calibration. The 0-100% slope reading corresponds to 0-59.2 mV/pH. A new sensor typically has a "slope" near 100%. When the slope decreases below approximately 80%, the sensor probably requires cleaning or replacement. For best slope reading accuracy, the millivolt input should be calibrated using the two-point method (Part Four, Section 2.2).

1.4 Avoiding Ground Loop Errors

The instrument may be affected by a "ground loop" electrical problem when there is moisture in a junction box. This condition provides a conductive pathway from the sensor connections to earth ground. To prevent a ground loop from occurring, keep terminal connections dry and corrosion-free.

1.5 Avoiding Electrical Interferences

Do not run sensor wires in the same conduit with line power. Excess wire should not be coiled near motors or other equipment that may generate electric or magnetic fields. Cut wires to proper length during installation to avoid unnecessary inductive pick-up ("electrical noise" may interfere with sensor signal).

1.6 Checking Buffers When Using "Two-Key" Table Method For pH Calibration

When using the "two-key" table method for pH calibration, best accuracy is attained when the buffers being used are of the same formulation as those selected from Table E. To verify this, find the corresponding buffer value table on the following page and compare its pH vs. temperature data with the data on the buffer bottle. Matching data confirms that the buffer is of the same formulation.

685 273

pH VS. TEMPERATURE DATA FOR TABLE "E" BUFFER FORMULATIONS

1.09 Buffer
HCl (DIN 19267)

°C	pH	°C	pH
0	1.08	50	1.11
10	1.09	60	1.11
20	1.09	70	1.11
30	1.10	80	1.12
40	1.10	90	1.13

1.68 Buffer
Tetraoxalate (NBS 260-53)

°C	pH	°C	pH
0	1.67	50	1.71
10	1.67	60	1.72
20	1.68	70	1.74
30	1.68	80	1.77
40	1.69	90	1.79

3.56 Buffer
Tartrate (NBS 260-53)

°C	pH	°C	pH
20	3.56	60	3.56
30	3.55	70	3.58
40	3.55	80	3.61
50	3.55	90	3.65

3.78 Buffer
Citric Acid (DIN 19266)

°C	pH	°C	pH
0	3.86	30	3.77
10	3.82	40	3.75
20	3.79	50	3.75

4.00 Buffer
Pthalate (DIN 19266)

°C	pH	°C	pH
0	4.00	50	4.05
10	3.99	60	4.08
20	3.99	70	4.12
30	4.00	80	4.15
40	4.02	90	4.20

4.01 Buffer
Pthalate (NBS 260-53)

°C	pH	°C	pH
0	4.01	50	4.06
10	4.00	60	4.09
20	4.00	70	4.12
30	4.01	80	4.16
40	4.03	90	4.19

4.65 Buffer
Acetate (DIN 19267)

°C	pH	°C	pH
0	4.67	50	4.68
10	4.66	60	4.70
20	4.65	70	4.72
30	4.65	80	4.75
40	4.66	90	4.79

6.87 Buffer
Phosphate (DIN 19266)

°C	pH	°C	pH
0	6.98	50	6.83
10	6.92	60	6.84
20	6.88	70	6.85
30	6.85	80	6.86
40	6.84	90	6.88

7.00 Buffer
Phosphate

°C	pH	°C	pH
0	7.10	50	6.98
10	7.06	60	6.98
20	7.02	70	6.97
30	6.99	80	6.99
40	6.97	90	7.01

7.41 Buffer
Phosphate (DIN 19266)

°C	pH	°C	pH
0	7.53	30	7.40
10	7.47	40	7.38
20	7.43	50	7.37

9.18 Buffer
Borax (NBS 260-53)

°C	pH	°C	pH
0	9.46	30	9.14
10	9.33	40	9.07
20	9.23	50	9.01

10.00 Buffer
Carbonate/Bicarbonate
(0.5 Molar)

°C	pH	°C	pH
0	10.26	50	9.80
10	10.15	60	9.73
20	10.05	70	9.68
30	9.96	80	9.63
40	9.87		

10.00 Buffer
Glycol

°C	pH	°C	pH
0	10.80	50	9.42
10	10.45	60	9.21
20	10.14	70	9.01
30	9.88	80	8.83
40	9 64	90	8.66

12.45 Buffer
Calcium Hydroxide (DIN 19266)

°C	pH	°C	pH
0	13.42	40	11.98
10	13.00	50	11.71
20	12.63	60	11.45
30	12.29		

SECTION 2 - mV CALIBRATION

If the instrument is used to measure the mV output of the pH sensor for diagnostic purposes, it is recommended for best accuracy to calibrate the display for mV using the single or two-point method.

2.1 Single-Point Method

This method requires a millivolt generator.

1. Disconnect the pH sensor or combination electrode.
2. Connect the millivolt generator in one of the following ways:

   A. When Using GLI 5-Wire Differential Sensor

   Connect generator (–) lead to GRN terminal and generator (+) lead to RED terminal on TB2.

   B. When Using Combination Electrode

   Connect generator (–) lead to TB4 (REF.) terminal and generator (+) lead to TB5 (ACTIVE) terminal post.
3. Set millivolt generator to provide (+) 200 mV.
4. Press **DISP VAR** key as needed to place display mV.
5. Press **EXAM/CANCEL** key to place display in "examination" mode and to indicate mV "CAL VALUE".
6. The display should indicate "(+) 200 mV". If not, use ← and ↑ keys to make display indicate "200 mV".
7. Press **ENTER** key to enter value (display flashes "OK" to confirm entry and returns to mV measuring mode). "HI/LO ERROR" flashes if the difference between the entry value and actual measured value is greater than 50 mV.

This completes the single-point mV calibration.

2.2 Two-Point Method

This method requires a millivolt generator.

1. Disconnect the pH sensor or combination electrode.
2. Connect the millivolt generator in one of the following ways:

   A. When Using GLI 5-Wire Differential Sensor

   Connect generator (–) lead to GRN terminal and generator (+) lead to RED terminal on TB2.

   B. When Using Combination Electrode

   Connect generator (–) lead to TB4 (REF.) terminal and generator (+) lead to TB5 (ACTIVE) terminal post.

3. Set millivolt generator to provide (–)180 mV.
4. Press **DISP VAR** key as needed to display mV.
5. Press **EXAM/CANCEL** key to place display in "examination"mode.
6. Press **NEXT** key once to make display indicate mV "LO CAL VALUE".
7. The display should indicate "(–) 180 mV". If not, use ⬅ and ⬆ keys to make display indicate "180 mV". To display minus sign, press ⬅ key until minus sign flashes at far left of display. Then press ⬆ key to retain minus sign indication.
8. Press **ENTER** key to enter value (display flashes "OK" to confirm entry and returns to mV measuring mode).
9. Set millivolt generator to provide (+) 180 mV.
10. Press **EXAM/CANCEL** key to place display in "examination" mode.
11. Press **NEXT** key twice to make display indicate mV "HI CAL VALUE".
12. The display should indicate "(+) 180 mV". If not, use ⬅ and ⬆ keys to make display indicate "180 mV".
13. Press **ENTER** key to enter value (display flashes "OK" to confirm entry and returns to mV measuring mode).

This completes the two-point mV calibration.

SECTION 3 - SIMULATING MEASURED VALUES

To aid in setting up a load device in the the 4-20 mA loop (recorder, controller, etc.), pH values may be simulated. This can only be accomplished when the security lock feature is in the unlock mode (Part Three, Section 8.2). Accessing the "SIM VALUE" setup variable displays a pH value. After entering a simulation value, the 4-20 mA loop current corresponding to the displayed value is provided. Changing the simulation value also changes the loop current value respectively. Exiting the "SIM VALUE" setup variable returns the loop current to tracking the measured pH. The output hold feature (Part Three, Section 7.2) may be used in conjunction with an entered simulation value. This allows a simulation value to be entered and the loop current corresponding to that value to be held, for example while calibrating the 692P.

To simulate a desired value:

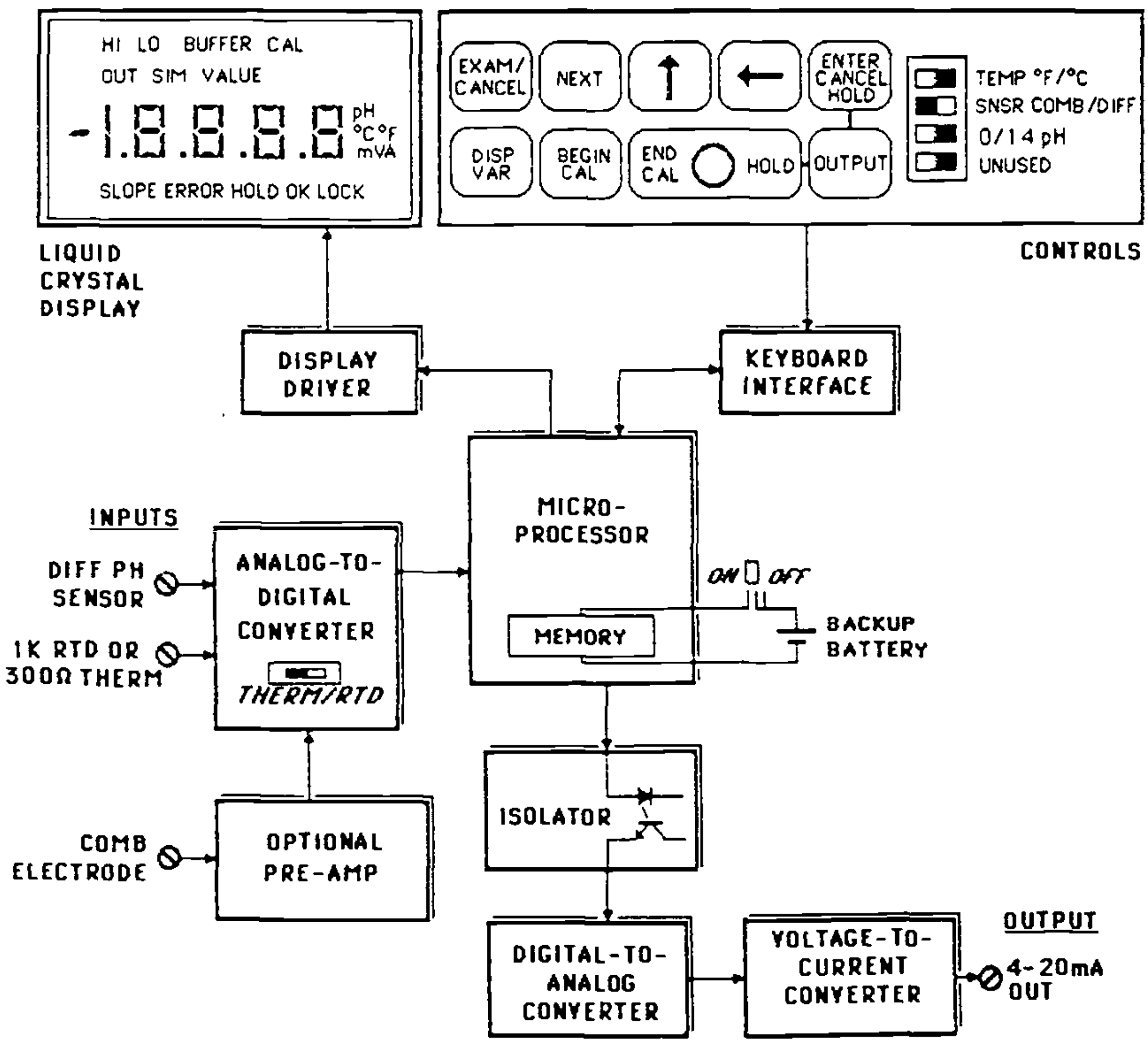
1. With display in pH measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "SIM VALUE".
3. Use ↑ and ← keys to make display indicate the desired simulation value.
4. Press **ENTER** key to enter value ("OK" flashes to confirm entry). The loop current value changes from tracking measured pH to that which corresponds to the entered simulation value.
5. To cancel the simulation value, press **EXAM/CANCEL** key.

PART FIVE - PRINCIPLE OF OPERATION

See Figure 5-1 for functional diagram pertaining to these descriptions:

1. The power-supply section (not shown) converts line power to appropriate voltages for circuit operation.

2. The analog-to-digital converter section accepts signals from the pH sensor (GLI 5-wire Differential Technique sensor or combination electrode) and from a temperature sensor (300 ohm thermistor or 1000 ohm platinum RTD). This section converts these analog pH and temperature signals to digital signals for use by the microprocessor.



Controls and jumpers are listed in *ITALICS.*

FIGURE 5-1 Instrument Operations Block Diagram

3. Using the pH and temperature signals, the microprocessor computes the temperature compensated pH value. The microprocessor also performs the various control algorithms, updates the liquid crystal display, monitors the keypad and other configuration switches and controls the loop current. The user-entered calibration and configuration values are retained in a battery backed-up memory.

4. The liquid crystal display indicates the process-related values (pH, temperature, mV, and 4-20 mA current output value) along with a variety of annunciators to indicate the status of the transmitter. The display also indicates setup variable values, error messages and diagnostic information.

5. The keypad and configuration switches are continuously monitored by the microprocessor. Based on the status of these inputs, the microprocessor immediately initiates the appropriate action.

6. The 4-20 mA analog output is controlled by the microprocessor. The output value is sent through an optical isolator for isolation and then to the digital-to-analog converter section. The analog output is isolated from the input.

685 279

PART SIX - SERVICE AND MAINTENANCE

SECTION 1 - GENERAL

1.1 Inspecting Sensor Cable

If a measurement problem exists and the sensor cable is suspected, inspect it for physical damage. If interconnect cable is used, disconnect cable at the sensor and instrument, and check wires for internal shorts with an ohmmeter.

1.2 Checking System Periodically

Depending on the application, system calibration should be performed periodically to maintain measurement accuracy. Frequent checks are suggested until operating experience can determine the optimum time between checks that provides acceptable measurement results.

SECTION 2 - TROUBLESHOOTING

2.1 System Diagnostic Error Messages

Improper operation is signaled by a flashing **ERROR** indicator while the display alternates between a measured value and one of the following error messages:

Table F – SYSTEM DIAGNOSTIC ERROR MESSAGES/MEANINGS

Error Message	Meaning
"Err 1"	pH input is out-of-range ("pH" flashes).
"Err 2"▲	Temperature input is out-of-range ("°C" or "°F" flashes).
"Err 3"	pH and temperature input is out-of-range (pH and "°C" or "°F" flashes).
"Err 4"	Memory loss (default values are in use).

▲In the absence of a valid temperature input ("Err 2"), the pH reading will be based on 25°C.

These error messages are only displayed in the measurement mode. During a configuration or calibration procedure, an error message is not displayed. Upon completing the procedure, an error message will be displayed if the condition has not been corrected.

NOTE: When an "Err 4" message appears, all user-entered values are lost and replaced by factory-set default values (see Tables B, C and D). The "Err 4" message can be cleared by pressing the ***ENTER/CANCEL HOLD*** *key. Correct the condition that caused the memory loss (see Table G). The instrument must then be recalibrated (Part Three, Section 6) and reconfigured.*

2.2 Resetting Instrument To Factory-Default Values

Unusual conditions such as lightning (or high voltage power surges), excessive electrical interference, or electrostatic discharge could alter the instrument's memory, causing false error messages or garbled data to be displayed. To correct this and restore normal operation, the instrument must be reset. This procedure replaces all user-entered values with factory-default values. Therefore, note your setup values in Table B before resetting the instrument.

1. With display in pH measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "SLOPE". Then press **NEXT** key once more to display "0000" (identifier for security lock feature).

   NOTE: If security lock feature is in use (LOCK status indicator is lit), it must be disabled at this time. Use ↑ and ← keys to make display indicate the unlock code "1234" and then press ENTER key.

3. With security lock feature disabled, use ↑ and ← keys to make display indicate the reset code "5678".
4. Press **ENTER** key to enter reset code (display alternately flashes "ERROR" and "Err 4" with a measured value).
5. Press **ENTER** key once more to clear the "ERROR" and "Err 4" message (only measured value is now displayed).
6. Recalibrate the instrument and enter noted setup values.

2.3 Isolating The Problem

A few simple checks can determine if the measuring system (sensor and instrument) is functioning properly. This section is intended to isolate the problem to a particular element of the system. If the conditions for each part of this section are met, the system is verified to be operating properly. If not, Table G at the end of this section lists common symptoms and causes to aid in identifying problems.

Checking Electrical Connections

1. Verify that power is reaching appropriate instrument terminals.
2. Push ribbon-cable connector halves together as tightly as possible.

# # #

Checking The Instrument

1. Disconnect sensor or combination electrode wires from the instrument. Simulate the pH and temperature inputs by connecting:

   A. A 1%, 1/4 watt, 301 ohm resistor across the yellow and black terminals on TB2 (Figure 3-2).

685 281

B. A jumper across the green and red terminals on TB2.

C. A jumper across the green and black terminals on TB2.

2. If a GLI 5-wire Differential Technique sensor was used, make sure the following switches are at these settings. If a combination electrode was used, place these switches to these settings:

Control	Setting
SWITCH 3 (Figure 3-2)	**DIFF** (off/right) position
TEMP. COMP. switch .... (Figure 3-2)	**THERM** position

3. In the pH measurement mode, the display should indicate approximately "7 pH".

4. Press **DISP VAR** key once to display temperature. The readout should be approximately "25°C" or "77°F".

5. Remove jumper from green and red terminals on TB2. In its place, connect a millivolt generator (+) lead to red terminal and (–) lead to green terminal and provide 175 mV DC.

6. Press **DISP VAR** key three times to return display to pH measurement mode. The readout should be approximately "4 pH".

   If these checks are accomplished, the instrument is operating properly, but the sensor or interconnect cable (if used) may be defective. Proceed with step 7. If these readings cannot be attained, the instrument is probably defective.

7. Remove the 301 ohm resistor and millivolt generator from TB2. Reconnect the sensor directly to the instrument (purposely excluding interconnect cable, if used). For a combination electrode, place switches in appropriate positions (refer to Part Two, Section 3.2). Calibrate the instrument for pH using the conventional two-point method described in Part Three, Section 6.3.

   If calibration is accomplished, the instrument and sensor are operating properly. If the system cannot be properly calibrated, the sensor is probably defective.

8. If interconnect cable is used and step 7 determines that the instrument and sensor operate properly, the interconnect cable is probably defective.

Table G – TROUBLESHOOTING COMMON PROBLEMS	
Symptom	Typical Causes
Display is completely blank.	1. Power is not present or connected. 2. Ribbon cable plug from display module assembly is not properly connected into power-supply board assembly.
Display shows "Err 1" message and flashing "pH" indicator.	pH input signal is out of range (pH sensor may be defective or sensor cable may be shorted or open).
Display shows "Err 2" message and flashing "°C" or "°F" indicator.	Temperature input signal is out of range (temperature sensor may be defective or sensor cable may be shorted or open).
Display shows "Err 3" message and flashing "pH" and "°C" or "°F" indicators.	The pH and temperature input signals are out of range (pH and temperature sensors may be defective or both sensor cables may be shorted or open).
Display shows "Err 4" message.	1. Memory backup battery is defective. Replace battery. 2. **BATTERY** jumper (Fig. 3-2) is missing or in **OFF** position. Refer to note in Part Six, Section 2.1.
The output value remains fixed when the process value is known to be changing.	Output hold feature is temporarily holding the output. Simultaneously press **CANCEL HOLD** and **OUTPUT** keys to cancel hold feature.
Valid setup variable values cannot be entered.	Instrument is in "lock" mode. Enter unlock code to unlock instrument (Part Three. Section 8.2).

2.4 Customer Assistance

Should service, parts or assistance in troubleshooting or repair be required, please contact your GLI representative or the GLI Customer Service Department:

Great Lakes Instruments, Inc.
8855 North 55th Street
Milwaukee, Wisconsin 53223
Telephone: 414/355-3601
Telefax: 414/355-8346

— SERVICE HOURS —

	Eastern Std. Time	Central Std. Time	Mountain Std. Time	Pacific Std. Time
Monday through Thursday	9:00 a.m. to 5:30 p.m.	8:00 a.m. to 4:30 p.m.	7:00 a.m. to 3:30 p.m.	6:00 a.m. to 2:30 p.m.
Friday	9:00 a.m. to 2:00 p.m.	8:00 a.m. to 1:00 p.m.	7:00 a.m. to 12:00 p.m.	6:00 a.m. to 11:00 a.m.

When ordering spare or replacement board assemblies, be sure to use the **complete** assembly part number.

All instruments or board assemblies returned for repair, freight prepaid, should also include the following information:

1. A clearly written description of the malfunction.
2. Name of person to contact and the phone number where they can be reached.

685 283

3. Proper return address for shipping instrument(s) back. Include preferred shipping method (UPS, Federal Express, etc.) if applicable.

4. A purchase order if instrument(s) or board assemblies are out of warranty to cover costs of repair.

NOTE: *If the instrument or board assemblies are damaged during return shipment as a result of inadequate packaging, the customer assumes responsibility for repair costs. It is recommended to use the original GLI shipping carton or an equivalent. Also, GLI will not accept instruments returned for repair or replacement unless they are thoroughly cleaned and all process material is removed.*

PART SEVEN - SPARE PARTS AND ACCESSORIES

	Description	Part Number
Spare Parts	Program Jumpers (7 per package)	670X4A1140
	Backup Battery, 3 V lithium	99X3A1073
	Display Module Assembly (3 boards—includes LCD and door assembly with keyboard overlay)	692M4G1110
	Liquid Crystal Display	99X6Q1094
	Door Assembly w/Keyboard Overlay	1000M4G1181
	Enclosure w/Potted Terminal Board	1000M4G1178
	Terminal Compartment Cover (Includes 4 captive fasteners and Model 692 label—specify for pH)	1000M4G1184
Accessories	Optional Input Board (allows transmitter to be retrofitted for use with conventional combination electrode)	692M4G1105
	Optional Pipe-mount Kit	1000M4G3065

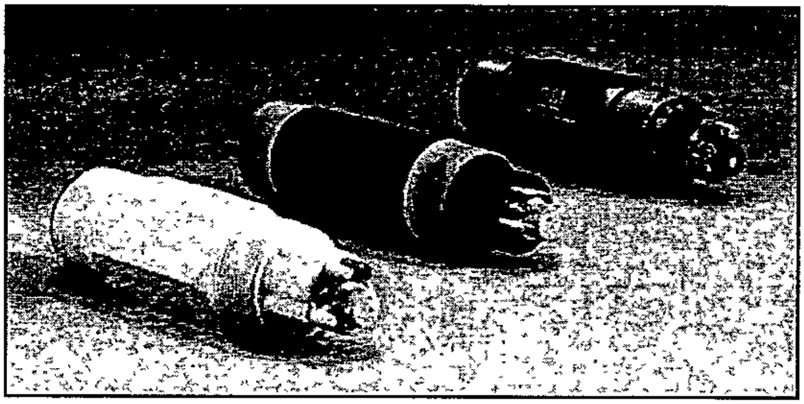
GLI International

Technology For Solutions

Data Sheet LRE/299
Supersedes LCP and Epoxy

Encapsulated Differential pH and ORP Sensors

(left to right: available in LCP, epoxy, and Ryton body materials)



Common Features

■ **Differential Electrode Measurement Technique.**
This field-proven technique uses three electrodes instead of the two normally used in conventional pH sensors Process and reference electrodes measure the pH differentially with respect to a third ground electrode. The end result is unsurpassed measurement accuracy, reduced reference junction potential, and elimination of sensor ground loops. These sensors provide greater reliability, resulting in less downtime and maintenance. For complete details on the Differential Sensor technology, request GLI Technical Bulletin TB-P5. For general pH measurement information, ask for our Technical Handbook on pH.

■ **Complete Encapsulation.**
Complete encapsulated construction protects the sensor's built-in electronics from moisture and humidity problems, extending the working life of the sensor.

■ **Built-in Preamp or Two-wire Transmitter.**
The built-in preamp produces a strong signal, enabling you to locate the analyzer up to 3000 ft. (914 m) from the sensor An optional built-in two-wire transmitter is available for applications requiring a 4-20 mA sensor signal. This option requires that the indicating instrument of the measuring system be capable of providing 24 VDC to power the sensor, and have adjustment means to calibrate for zero offset and span.

■ **Versatile Mounting Styles.**
Threads are provided on both ends of the convertible mounting style sensor for either mounting into a pipe tee or attaching to the end of a pipe for immersion. The convertible style enables you to consolidate inventory, and thereby reduce associated costs. A union-mount style sensor and mounting tee are also available to conveniently install and remove the sensor for in-line service. (See pages 4 and 5 for mounting hardware assemblies offered in a variety of materials.)

LCP Sensor

■ **Chemically-resistant LCP (liquid crystal polymer) Body.**
The exceptional chemical resistance and mechanical strength of the LCP sensor body makes it ideal for most applications These sensors can be used in aggressive process solutions such as acids, bases, alcohols, hydrocarbons, aromatics, chlorinated hydrocarbons, esters, ketones, and most other chemicals.

■ **Low Heat Distortion.**
LCP sensors are physically stable and will not expand or contract when subjected to the heating and cooling cycles of a process Furthermore, these sensors may be installed in metal fittings without fear of leakage, a common problem when dissimilar materials are threaded together.

Ryton Sensor

■ **Excellent, Strong Base Chemical Compatibility.**
The Ryton sensor is best suited for measuring strong base solutions of more than 12 pH at elevated temperatures. It can also be used in acidic solutions, but is not recommended when aromatic hydrocarbons are present.

Epoxy Sensor

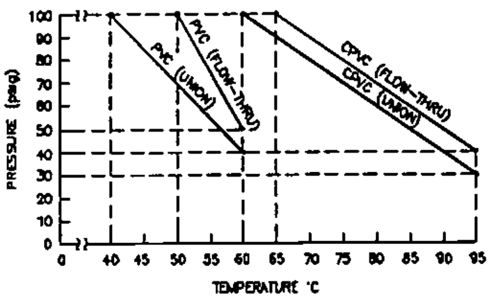
■ **General Purpose Usage.**
The epoxy-bodied sensor is ideal for measuring water, wastewater, and other relatively non-aggressive aqueous solutions in which epoxy is an acceptable wetted material.

685 286

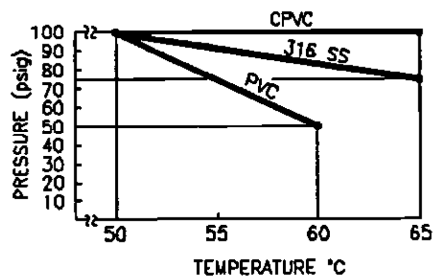
Specifications

Pressure/Temperature Limits
  Sensor Only (no hardware)
    LCP Sensor — -5°C (23°F) to 95°C
    Ryton Sensor — -5°C (23°F) to 95°C
    Epoxy Sensor — -5°C (23°F) to 95°C
  Sensor With Hardware* — See graphs below for specific GLI sensor and mounting hardware combinations

LCP and Ryton Sensor/Plastic Mounting Hardware Ratings



Epoxy Sensor/Plastic Mounting Hardware Ratings



* An LCP or Ryton-encapsulated sensor that is mounted in a plastic flow-through tee has a higher pressure rating at maximum temperature than when it is mounted in a union tee The temperature rating is increased to 95°C at 100 psig when the sensor is mounted in a stainless steel flow-through or union tee, or a stainless steel cross

  The maximum operating temperature rating for epoxy-encapsulated sensors when used with PVC mounting hardware is 60°C at 50 psi or 50°C at 100 psi When CPVC hardware is used, the rating increases to 65°C at 100 psi When used with a stainless steel tee or cross, the rating is 65°C at 75 psi or 50°C at 100 psi

Maximum Flow Rate — 10 ft (3 m) per second

	pH Sensors	ORP Sensors
Wetted Materials LCP Sensor	LCP (liquid crystal polymer) body and salt bridge with PVDF (or ceramic) junction, glass process electrode, titanium ground electrode, and Viton O-ring process seals. Union-mount style sensor also has LCP adapter pH sensor with optional antimony process electrode has stainless steel ground electrode	LCP (liquid crystal polymer) body and salt bridge with PVDF (or ceramic) junction, glass and platinum (or glass and gold) process electrode, titanium ground electrode, and RTV sealant Union-mount style sensor also has LCP adapter and Viton O-ring process seals.
Epoxy Sensor	Epoxy body, LCP and PVDF (or ceramic) salt bridge, glass process electrode, titanium ground electrode, and RTV sealant. Union-mount style sensor also has Viton O-ring process seals	Epoxy body, LCP and PVDF (or ceramic) salt bridge, glass and platinum (or glass and gold) process electrode, titanium ground electrode, and RTV sealant. Union-mount style sensor also has Viton O-ring process seals
Ryton Sensor	Ryton body and salt bridge with PVDF (or ceramic) junction, glass process electrode, titanium ground electrode, and Viton O-ring process seals Union-mount style sensor also has Ryton adapter. pH sensor with optional antimony process electrode has stainless steel ground electrode	Ryton body and salt bridge with PVDF (or ceramic) junction, glass and platinum (or glass and gold) process electrode, titanium ground electrode, and RTV sealant. Union-mount style sensor also has Ryton adapter and Viton O-ring process seals
Measuring Range		
LCP and Ryton Sensors	0-14 pH (see Note 1)	-2000 to +2000 mV (see Note 2)
Epoxy Sensor	4-10 pH (see Note 1)	-2000 to +2000 mV (see Note 2)

Specifications (continued)

	pH Sensors	ORP Sensors
Sensitivity	Less than 0 005 pH	Less than 0 5 mV
Stability	0 03 pH per 24 hours, non-cumulative	2 mV per 24 hours, non-cumulative
Output Span (only with 2-wire transmitter)	0 95 mA per pH unit	16 mA per 1000 mV
Output Offset (only w/2-wire transmitter)	12 mA occurs at 7 0 pH, ±0 88 pH (see Note 3)	-500 to +500 mV range 12 mA occurs at 0 mV, ±40 mV 0 to 1000 mV range 12 mA occurs at 500 mV, ±40 mV
Load at 20 mA (only with 2-wire transmitter)	450 ohms	450 ohms
Maximum Transmission Distance		
Sensor with Preamplifier	3000 ft (914 m)	3000 ft (914 m)
Sensor with 2-wire Transmitter	Limited only by wire resistance and power supply voltage	Limited only by wire resistance and power supply voltage
Sensor Cable (standard)		
Sensor with Preamplifier	5 conductor (plus shield), 10 ft. (3 m) long	5 conductor (plus shield), 10 ft (3 m) long
Sensor with 2-wire Transmitter	2 conductor (twisted pair), 10 ft (3 m) long	2 conductor (twisted pair); 10 ft (3 m) long

NOTES:

1 Most pH applications fall in the 2 5-12 5 pH range General purpose pH glass electrodes perform well in this range For pH applications below 4 or above 10 pH, GLI recommends using an LCP-bodied pH sensor Some industrial applications require accurate measurement and control below 2 or above 12 pH In these cases, please contact GLI for further details

Repeatability and speed of response of a pH sensor with an optional antimony process electrode is not as good as a sensor with a glass process electrode Antimony electrodes are only linear between 3 and 8 pH, and should only be ordered when process conditions, such as the presence of hydrofluoric acid, dictate their use

2 For ORP applications where zinc, cyanide, cadmium, or nickel are present, specify the optional gold electrode instead of the standard platinum electrode.

3 A pH sensor with a built-in two-wire transmitter provides a non-isolated and uncalibrated 4-20 mA output The indicating instrument of the measuring system must be able to provide 24 VDC to power this sensor, and have adjustment means to calibrate for zero offset and span

Ordering Information

TYPE OF MEASUREMENT
- **20** ORP, 5-wire (with built-in preamplifier)
- **24** ORP, 2-wire (with built-in two-wire transmitter providing 4-20 mA output)
- **60** pH, 5-wire (with built-in preamplifier)
- **64** pH, 2-wire (with built-in two-wire transmitter providing 4-20 mA output)

MOUNTING STYLE (each style has integral 10 ft./3 m long cable)
- **2** Convertible (immersion or flow-through mount – see Note A below)
- **5** Union-mount. For LCP and Ryton (includes adapter, but requires special 2-inch threaded tee)
  For Epoxy (requires 1-1/2 inch union tee)

BODY MATERIAL
- **1** Epoxy
- **2** Ryton (for elevated temperatures in high pH applications)
- **8** LCP (liquid crystal polymer)

ELECTRODE MATERIAL
- **P0** Glass (only for pH – general purpose)
- **P1** Antimony (only for pH -- only available for LCP and Ryton sensors)
- **R0** Platinum (only for ORP -- see Note B)
- **R1** Gold (only for ORP -- see Note B)

☐ **Product Number**

Choose one from each category.

NOTES: **A.** When immersion mounting a convertible style sensor, it is recommended to order an LCP protector 60A2F1278 or Ryton protector 60A2F1278-300 The protector, shown in Figure 1 on page 5, threads onto the end of the sensor

B. For solutions containing zinc, cyanide, cadmium, or nickel, specify the gold electrode for best measurement results

Accessories (order separately):

- **Interconnect Cables:**

  1W1055 -- This cable is for use with only 5-wire sensors Specify required length in whole feet

  1W0980 -- This cable is for use with only 2-wire sensors Specify required length in whole feet

- **Union Adapters:**

  60G9753-101 -- Spare LCP adapter includes two Viton O-rings and a retaining ring

  60G9753-301 -- Spare Ryton adapter includes two Viton O-rings and a retaining ring

- **pH Buffers (in resealable 1-pint plastic bottles):**

  3A0421 -- pH 7 Buffer
  3A0422 -- pH 4 Buffer
  3A0942 -- pH 10 Buffer

- **Self-contained Air Blast Cleaning Systems:**

  1000A3335-002 -- For 115 VAC operation
  1000A3335-003 -- For 230 VAC operation

  Each system above includes the washer head with 25 ft (7 6 m) long tubing for air delivery, a quick-disconnect tube fitting, and a compressor housed in a NEMA 4X enclosure

- **Air/Water Blast Cleaning Washer Head**

  1000A3335-001 -- includes 1/4-inch barb fitting (see drawing on page 7), only for immersion applications with user-supplied air or water wash system

- **Salt Bridges for GLI Differential Sensors**

  The double junction salt bridge on the standard cell of all GLI Differential Technique sensors is field-replaceable, and includes appropriate O-ring(s) Salt bridges are shipped in specified quantities in a salt solution Please specify the desired quantity by substituting the corresponding Quantity Code for the "XXX" portion of the salt bridge part number

Salt Bridge Usage Guide

Part Number (XXX = Qty Code)	Use With These GLI Differential Sensors	Salt Bridge Materials	
		Body	Outer Junction
60-9764-000-XXX	Ryton only	Ryton	Kynar
60-9764-010-XXX	Ryton only	Ryton	Ceramic
60-9765-000-XXX	LCP and Epoxy	LCP	Kynar
60-9765-010-XXX	LCP and Epoxy	LCP	Ceramic

NOTE: Each salt bridge has a ceramic inner junction and Viton O-ring, and contains binary fill solution

Salt Bridge Quantity Code

Quantity	Code
1	001
2	002
3	003
5	005
10	010
50	050

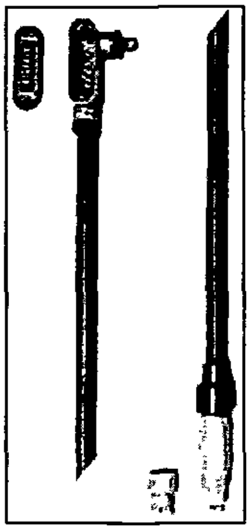
- **Standard Cell Solution for GLI Differential Sensors**

  25M1A1001-115 -- Use this pH 7 solution to replace the solution in the standard cell chamber when replacing the salt bridge The solution is provided in a resealable 500 ml bottle

Ordering Information (continued)

Sensor Mounting Hardware

FIGURE 1 Immersion Mounting

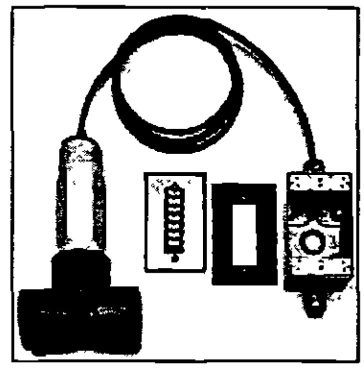


(LCP sensor pictured)

Part Number	Description
MH474B	PVC pipe (1 inch diameter by 4 ft./1 2 m long) & coupling with PVC pipe-mount j-box
MH434B	CPVC pipe (1 inch diameter by 4 ft /1 2 m long) & coupling with PVC pipe-mount j-box
60A2F1278	LCP protector (ordered separately)
60A2F1278-300	Ryton Protector (ordered separately)

NOTE: Hardware does not include the sensor or interconnect cable which must be ordered separately

FIGURE 2 Flow-through Mounting

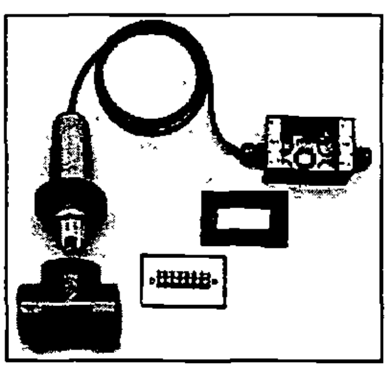


(LCP sensor pictured)

Part Number	Description
MH376	PVC 1-1/2 inch tee and aluminum j-box
MH336	CPVC 1-1/2 inch tee and aluminum j-box
MH316N	316 SS 1-1/2 inch tee and aluminum j-box
MH346X	316 SS 1-1/2 inch cross and aluminum j-box

NOTE: Hardware does not include the sensor or interconnect cable which must be ordered separately

FIGURE 3 Union Mounting -- LCP and Ryton Sensor

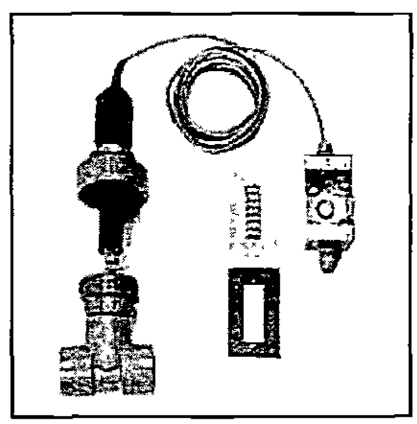


(Ryton union-mount sensor pictured)

Part Number	Description
MH578N9A	PVC 2 inch special tee and aluminum j-box
MH538N9A	CPVC 2 inch special tee and aluminum j-box
MH518N9A	316 SS 2 inch special tee and aluminum j-box

NOTE: Hardware does not include the sensor or interconnect cable which must be ordered separately

FIGURE 4 Union Mounting -- Epoxy Sensor



(Epoxy union-mount sensor pictured)

Part Number	Description
MH576	PVC 1-1/2 inch tee with union and aluminum j-box
MH536	CPVC 1-1/2 inch tee with union and aluminum j-box

NOTE: Hardware does not include the sensor or interconnect cable which must be ordered separately

Engineering Specification

LCP Sensor

1. The pH or ORP sensor shall be of Differential Electrode Technique design which uses two electrodes to compare the process value to a stable internal reference standard buffer solution The standard electrode shall have non-flowing and fouling resistant characteristics

2. The sensor shall have a hex-shaped body to facilitate mounting, and shall be constructed of liquid crystal polymer for exceptional chemical resistance and mechanical strength This material shall enable the sensor to be installed in metal fittings without leakage usually caused by heating and cooling cycles when dissimilar materials are threaded together

3. The sensor's built-in electronics shall be completely encapsulated to protect them from moisture and humidity

4. The sensor shall have a built-in preamplifier to enable the signal to be transmitted up to 3000 ft (914 m) with standard cabling, or a built-in two-wire transmitter that provides a non-isolated and uncalibrated 4-20 mA output

5. The sensor signal shall be automatically temperature compensated by an integral temperature sensor

6. The sensor shall include a metal ground electrode to eliminate ground loop currents in the measuring electrodes.

7. The sensor shall be GLI International, Inc Model 6XX8P-series for pH measurement or 2XX8R-series for ORP measurement

Ryton Sensor

1. The pH or ORP sensor shall be of Differential Electrode Technique design which uses two electrodes to compare the process value to a stable internal reference standard buffer solution The standard electrode shall have non-flowing and fouling resistant characteristics

2. The sensor shall have a hex-shaped body to facilitate mounting, and shall be constructed of Ryton for exceptional chemical resistance and mechanical strength This material shall enable the sensor to be installed in metal fittings without leakage usually caused by heating and cooling cycles when dissimilar materials are threaded together

3. The sensor's built-in electronics shall be completely encapsulated to protect them from moisture and humidity

4. The sensor shall have a built-in preamplifier to enable the signal to be transmitted up to 3000 ft (914 m) with standard cabling, or a built-in two-wire transmitter that provides a non-isolated and uncalibrated 4-20 mA output

5. The sensor signal shall be automatically temperature compensated by an integral temperature sensor

6. The sensor shall include a metal ground electrode to eliminate ground loop currents in the measuring electrodes

7. The sensor shall be GLI International, Inc Model 6XX2P-series for pH measurement or 2XX2R-series for ORP measurement

Epoxy Sensor

1. The pH or ORP sensor shall be of Differential Electrode Technique design which uses two electrodes to compare the process value to a stable internal reference standard buffer solution The standard electrode shall have non-flowing and fouling resistant characteristics.

2. The sensor shall be constructed of epoxy

3. The sensor's built-in electronics shall be completely encapsulated to protect them from moisture and humidity

4. The sensor shall have a built-in preamplifier to enable the signal to be transmitted up to 3000 ft (914 m) with standard cabling, or a built-in two-wire transmitter that provides a non-isolated and uncalibrated 4-20 mA output

5. The sensor signal shall be automatically temperature compensated by an integral temperature sensor

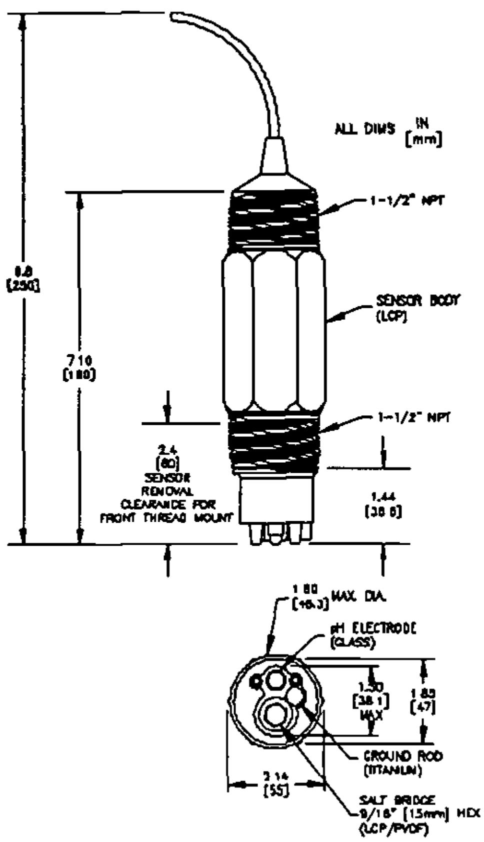
6. The sensor shall include a metal ground electrode to eliminate ground loop currents in the measuring electrodes

7. The sensor shall be GLI International, Inc Model 6XX1P-series for pH measurement or 2XX1R-series for ORP measurement

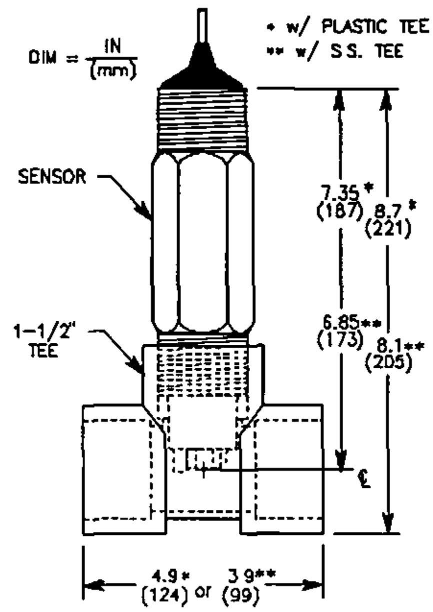
Dimensions

LCP and Ryton Sensors

Convertible Style Sensor

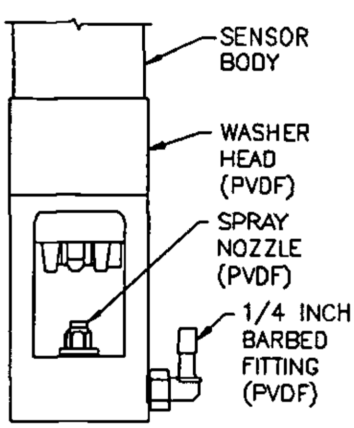


Flow-through Tee Mounting

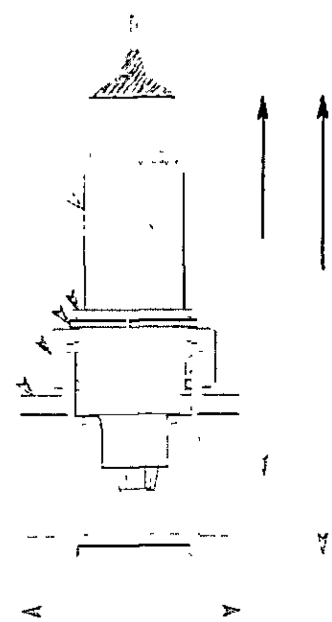


Air/Water Blast Cleaning Washer Head

(for LCP, Ryton, and epoxy sensors -- only for immersion applications)



Union Tee Mounting



685 292

GLI International

OPERATING INSTRUCTION MANUAL

Manual No. 255
Revision 4-295

LCP*-ENCAPSULATED pH SENSORS

*Liquid Crystal Polymer

GLI International, Inc.
Great Lakes Instruments
9020 West Dean Road
Milwaukee, Wisconsin 53224

Phone: [414] 355-3601
Fax: [414] 355-8346

TABLE OF CONTENTS

685 294

TABLE OF CONTENTS (continued)

ILLUSTRATIONS:

WARRANTY/REPLACEMENT PLAN

Great Lakes Instruments, Inc. will replace—**free**—any sensor which fails within 1 year from the date of shipment (excluding failure due to physical breakage or misapplication of the sensor as determined by GLI). The date code. shown as a prefix in the sensor's serial number, identifies the month and year of shipment. If a GLI sensor fails for any reason—including physical damage—within 30 months, we will provide a replacement sensor at a substantially reduced price. GLI limits the warranty to replacement of the defective sensor which must be returned to the factory. freight prepaid, for examination. The sensor must be thoroughly cleaned and the process chemicals removed before it will be accepted for replacement or repair. GLI shall not be liable for any consequential damages, whether to person or property, caused by a defective sensor.

PART ONE - INTRODUCTION

SECTION 1 - GENERAL INFORMATION

1.1 Description

Electronics

The liquid crystal polymer-encapsulated pH sensor has either an integral preamplifier (identified by its 5-wire cable) or two-wire transmitter (identified by its 2-wire cable) which provides a 4-20 mA output. Both sensor types also have an integral temperature-sensitive resistor to automatically compensate pH measurements for temperature variations.

Mounting Styles

The LCP-encapsulated pH sensor is available in two mounting styles. The "convertible" mounting style sensor has a distinctive hex-shaped body for easy installation and is threaded at both ends. This style enables the sensor to be threaded onto the end of a pipe for submersion applications or mounted into a standard 1-1/2 inch NPT pipe tee for flow-thru applications. The "union-mount" style sensor has a union adapter and requires a special 2-inch threaded mounting tee for installation.

1.2 Operating Precautions

1. The output of the 2-wire type sensor is **non-isolated and uncalibrated.** Consequently, the measuring system's indicating instrument must be able to provide 24 VDC where low is isolated from earth ground to power the sensor and have adjustment means to calibrate for offset and span. Refer to the calibration procedure in the instrument instruction manual for details.
2. The process electrode at the tip of the sensor is glass which can easily break. Do not subject it to impact or other mechanical abuse.

   Caution: A broken glass electrode can cause serious cuts if not handled carefully.
3. pH sensors with glass electrodes must not be used in hydrofluoric acid which dissolves the glass. A sensor with an antimony electrode is recommended in this case.
4. Before placing the sensor into operation, **remove the protective plastic caps** to expose the process electrode and hex-shaped "salt bridge". Save caps for future use.

   NOTE: *If sensor is to be out of solution for more than a day or two, put a few drops of water in each cap and replace them on the sensor. This keeps the pH sensitive glass and salt bridge moist and avoids slow response when the sensor is put back into operation. This should be done every 2-4 weeks (depending on environmental conditions) for extended storage.*

SECTION 2 - SPECIFICATIONS

Min. Temperature ....-5°C (23°F)

Max. Temperature:

In Flow-Thru Tee ....PVC: 60°C at 50 psig or 50°C at 100 psig
Steel: 95°C at 100 psig
CPVC: 95°C at 40 psig or 65°C at 100 psig

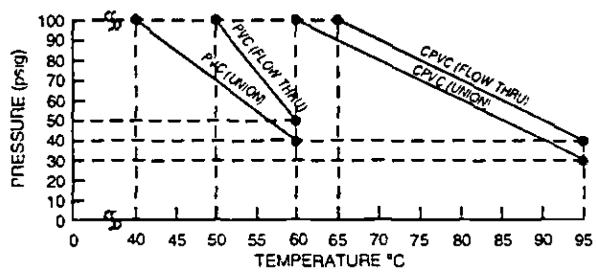
In Union Tee ....PVC: 60°C at 40 psig or 40°C at 100 psig
Steel: 95°C at 100 psig
CPVC: 95°C at 30 psig or 60°C at 100 psig

Maximum Pressure:

In Flow-Thru Tee ....PVC: 100 psig at 50°C or 50 psig at 60°C
Steel: 100 psig at 95°C
CPVC: 100 psig at 65°C or 40 psig at 95°C

In Union Tee ....PVC: 100 psig at 40°C or 40 psig at 60°C
Steel: 100 psig at 95°C
CPVC. 100 psig at 60°C or 30 psig at 95°C

Plastic Mounting Hardware Ratings



Maximum Flow Rate ....10 feet per second

***NOTE:** If possible, flow rate should be minimal for low conductivity water or solutions high in suspended solids.*

Wetted Materials ....Liquid crystal polymer body, liquid crystal polymer and PVDF (or ceramic) salt bridge, glass process electrode, titanium ground electrode and RTV sealant. Union-mount style sensor also has liquid crystal polymer adapter and Viton O-ring process seals. For pH sensors with an antimony process electrode, stainless steel replaces the titanium ground electrode.

685 297

Measuring Range .... 0-14 pH

NOTE: Most pH applications fall in the 2.5 - 12.5 pH range. General purpose pH glass electrodes perform well in this range. Some industrial applications require accurate measurements and control at pH values below 2 or above 12. Consult GLI for details on these applications.

Repeatability and speed of response for pH sensors with an antimony process electrode is not as good as those with a glass process electrode. Antimony electrodes are only linear between 3 and 8 pH and should only be specified when process conditions, such as the presence of hydrofluoric acid, dictate their use.

Performance:

Sensitivity .... Less than 0.005 pH

Stability .... 0.03 pH units per 24 hrs., non-cumulative

For Sensor w/Two-wire Transmitter:

Output Span .... 0.95 mA per pH

Output Offset .... 12 mA occurs at 7.0 pH (+) or (-) 0.88 pH

Load at 20 mA............. 450 ohms

Sensor Cable:

Sensor w/ Preamplifier .... 5 conductor (plus shield), 10 ft. (3 m) length

Sensor w/ Two-wire Transmitter..................... 2 conductor (twisted pair), 10 ft. (3 m) length

Transmission Distance:

Sensor w/ Preamplifier .... 3000 ft. (914 m) maximum

Sensor w/ Two-wire Transmitter..................... Limited by wire resistance and power supply voltage

PART TWO - INSTALLATION

SECTION 1 - LOCATION REQUIREMENTS

1. Mount the sensor vertically, electrodes down. If the sensor must be installed on an angle, it should be **at least 15° above horizontal**. Other mounting angles may cause erratic readings.
2. Use Teflon tape on sensor and mounting hardware threads to avoid leaks. Do not use pipe sealant.

SECTION 2 - MOUNTING

2.1 Submersion

The sensor may be submersion or tank mounted by threading it onto the end of a pipe of an appropriate length (Figure 2-1).

1. Screw a 1-1/2 inch x 1 inch NPT reducer coupling onto cable end ,of sensor. Route sensor cable through an appropriate length of 1-inch mounting pipe. Screw pipe into reducer coupling.
2. Run sensor cable into unilet junction box. Screw unilet box onto mounting pipe.
3. Run interconnect cable into unilet. Connect sensor and interconnect cable wires, by matching colors, to terminal strip in unilet. Fasten cover onto unilet.
4. Route interconnect cable to instrument. If cable is too long, cut it to proper length to avoid any interference from inductive pick-up. It is recommended to run this cable in 1/2" or larger flexible, metal conduit for protection against moisture and mechanical damage. Flexible conduit

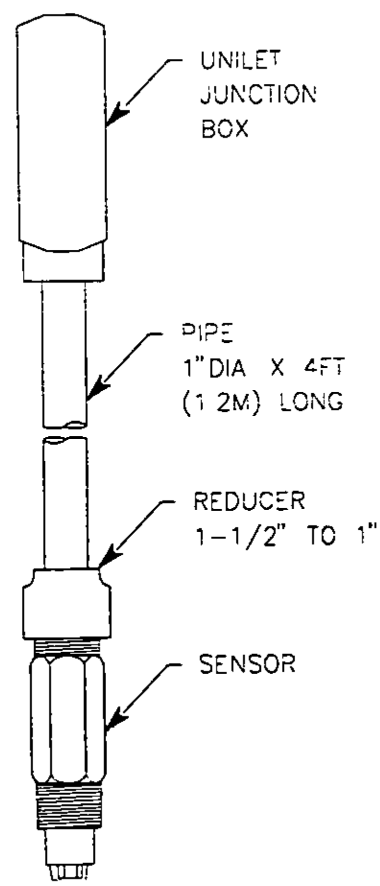


FIGURE 2-1
Submersion Mounting Details

685 299

must be long enough to allow removal of the sensor from the process for maintenance and calibration.

NOTE: *Do not run this cable in the same conduit with power or control wiring ("electrical noise" may interfere with sensor signal).*

5. Connect interconnect cable wires to instrument in accordance with instrument hook-up instructions.
6. Remove protective plastic caps from sensor and save for future use. Calibrate system with pH buffers using the procedure in the instrument instruction manual before mounting sensor/hardware assembly into the process.
7. Fasten electrode protector onto end of sensor. Mount sensor/hardware assembly by suitable means. This completes the submersion installation.

2.2 Flow Thru (Pipe Tee)

The sensor may be tee mounted by threading it into a standard 1-1/2-inch NPT pipe tee (Figure 2-2).

1. Install a standard 1-1/2 inch NPT pipe tee into the process line.
2. Electrically connect the sensor directly to the instrument or indirectly with a junction box and interconnect cable.
   A. Direct Hook-Up
      a. Route sensor cable to instrument. Use a watertight connector, such as a cable feed-thru fitting, in the instrument's cable entry hole.
      b. Connect sensor cable wires to instrument in accordance with instrument hook-up instructions.
   B. Indirect Hookup With Junction Box
      a. Mount junction box (with terminal strip) on a flat surface such that its cover is removable when installed.
      b. Route sensor cable to junction box through a watertight connector such as a cable feed-thru fitting.

         NOTE: *Keep terminal strip dry to prevent problems caused by wet and/or corroded terminals.*
      c. Route interconnect cable from junction box to instrument. If cable is too long, cut it to proper length to avoid any interference from inductive pick-up. It is recommended to run this cable in 1/2 inch or larger metal conduit for protection against moisture and mechanical damage. Use conduit

685 300

hubs where cable enters the junction box and instrument enclosure.

NOTE: *Do not run this cable in the same conduit with power or control wiring ("electrical noise" may interfere with sensor signal).*

d. Connect sensor and interconnect cable wires, by matching colors, to junction box terminal strip. Fasten cover onto junction box.

e. Connect interconnect cable wires to instrument in accordance with instrument hook-up instructions.

3. Remove protective plastic caps from sensor and save for future use. Calibrate system with pH buffers using the procedure in the instrument instruction manual before mounting sensor into the process line.

4. Purposely pre-twist the sensor cable by tuming the sensor counterclockwise (left) 4 to 5 tums. Now place sensor into tee and hand tighten. Use a large crescent or open-end wrench on the flat sides of the sensor body to carefully snug the connection to prevent leaks. **Do not overtighten!**

This completes the pipe tee installation.

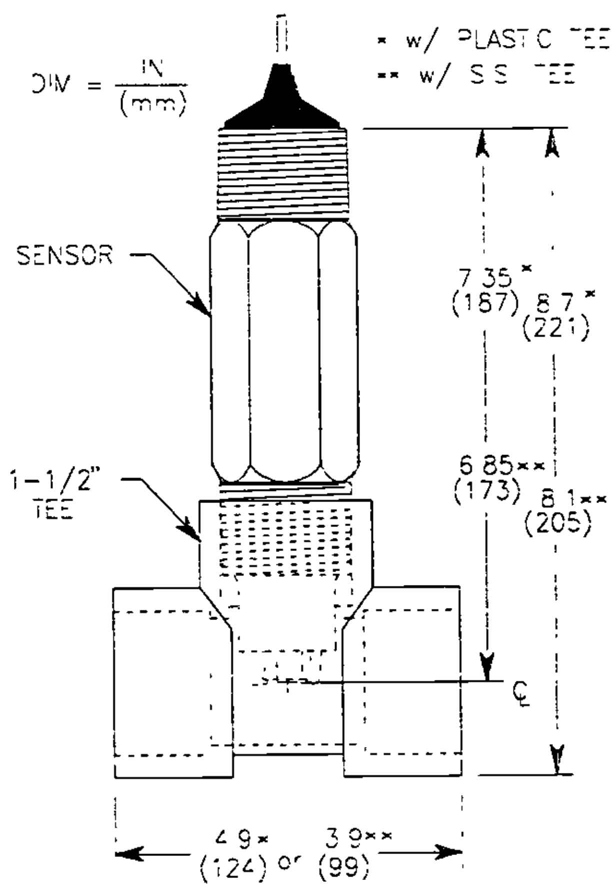


FIGURE 2-2 Tee Mounting Details

685 301

2.3 Union

The union-mount style sensor is installed by using a special 2-inch threaded mounting tee (Figure 2-3).

1. Install the special 2-inch threaded mounting tee into the process line.
2. Remove retaining ring from top portion of adapter.
3. Place lock ring onto adapter as shown in Figure 2-3 (threads on lock ring toward O-rings). Slip retaining ring over top of lock ring to hold it in place.
4. Electrically connect sensor to instrument as described in Section 2.2, step 2A or 2B.
5. Remove protective plastic caps from sensor and save for future use. Calibrate system with pH buffers using the procedure in the instrument instruction manual before mounting sensor into the process line.
6. Lubricate adapter O-rings with water to ease sensor insertion into tee and carefully place sensor into special tee. Hand tighten lock ring onto tee. This completes the union-mount installation.

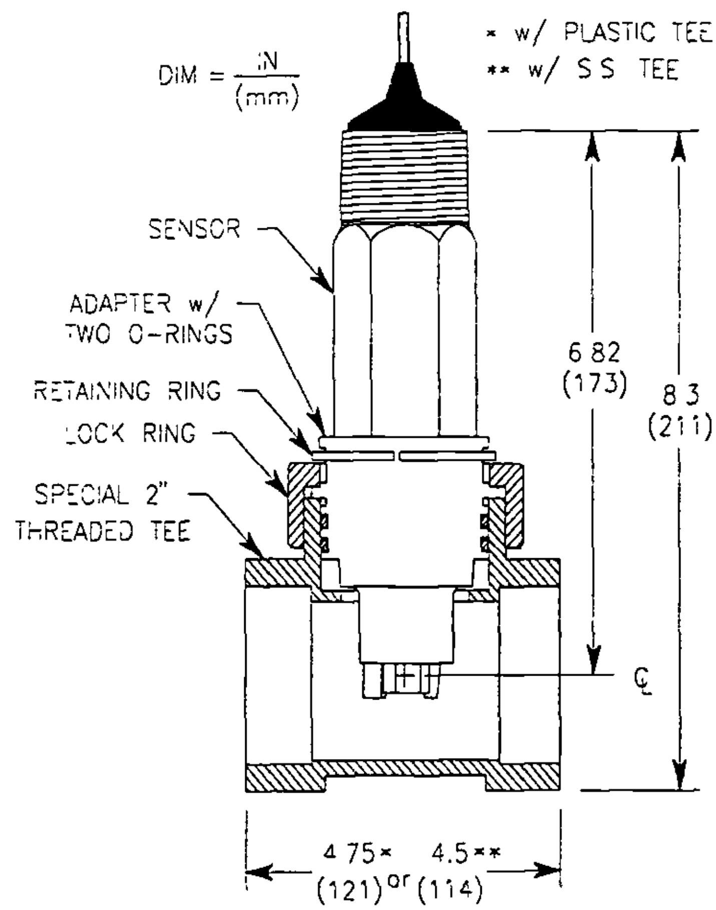


FIGURE 2-3 Union Mounting Details

PART THREE - PRINCIPLE OF OPERATION

The sensor operates in principle as if it contained two "batteries" whose voltages are measured and transmitted by electronic amplifiers. One battery is formed by the ground electrode and the glass process electrode. The voltage of this battery is a function of the solution pH. The other battery is formed by the same ground electrode and the standard electrode which contains a pH electrode in a chemical standard of fixed pH value (see Figure 4-1). The voltage of the second battery is subtracted from the voltage of the first battery. The result is a differential pH measurement, the final signal being that of a pH electrode in the process compared to a pH electrode in a chemical standard solution.

A temperature sensitive resistor inside of the sensor automatically compensates the pH measurement for temperature variations by adjusting the output of the sensor.

PART FOUR - SERVICE AND MAINTENANCE

SECTION 1 - RECOMMENDED CLEANING PROCEDURE

The sensor must be kept reasonably clean to maintain measurement accuracy. The time period between cleanings (days, weeks, etc.) is affected by the characteristics of the process solution and can only be determined by operating experience. For example, a sensor operating in waste water that contains oil and/or grease may require more frequent cleaning.

1. Rinse the sensor with clean, warm water.
2. Prepare a mild soap solution. Use warm water and dishwashing detergent or other non-abrasive soaps that do not contain lanolin which will coat the glass process electrode.
3. Soak the sensor for 2 to 3 minutes in the soap solution.
4. Using a **soft** bristle brush, scrub the entire measuring end of the sensor (glass process electrode, salt bridge and ground electrode).

   CAUTION: Performance can be degraded by scratching the glass electrode. Do not use a cleaning brush that can cause scratches.

685 303

5. Before cleaning with acid, determine if any hazardous reaction products could form. For example, a sensor used in a cyanide bath should not be put directly into a strong acid for cleaning because poisonous cyanide gas could be produced. Acids are hazardous and appropriate eye protection and clothing should be worn in accordance with Material Safety Data Sheet recommendations.

   Muriatic or other **dilute** acids may be used to clean the sensor. The acid should be as dilute as possible, but yet strong enough to clean. Experience will help to determine which acid to use and how dilute it can be. Some stubborn coatings may require a different cleaning agent. Contact the factory for assistance in these difficult cases.

   Soak the sensor in dilute acid for no more than 5 minutes. Rinse the sensor with clean, warm water and then place the sensor back into the mild soap solution for 2 to 3 minutes to neutralize the acid.

6. Rinse the sensor in clean, warm water.

7. Calibrate the sensor and instrument with pH buffers (refer to instrument instruction manual). If calibration cannot be accomplished, replace the sensor's standard cell buffer and salt bridge (Part Four, Section 2). If calibration is still not possible, troubleshoot the sensor in accordance with Part Four, Section 3.

SPECIAL CASE

Sensors which have an antimony (instead of glass) process electrode that still cannot be calibrated after normal cleaning and replacement of the standard cell buffer and salt bridge may require additional electrode cleaning. The antimony electrode is brittle and can easily break. Use care when cleaning it. **Very carefully** file the **tip** of the antimony electrode and lightly scrape its rounded sides to remove any process coating.

WARNING: ANTIMONY IS TOXIC! CAREFULLY DISPOSE ALL FILINGS IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS. WHEN FINISHED, WASH HANDS THOROUGHLY.

SECTION 2 - REPLACING STANDARD CELL BUFFER/SALT BRIDGE

The sensor's standard cell buffer and salt bridge should be replaced if calibration cannot be accomplished after cleaning the sensor. To do so:

1. Hold sensor in upright position and remove the hex-shaped salt bridge (Figure 4-1) by turning it counter-clockwise with a 9/16" socket or nut driver to initially loosen it. Take care not to damage the protruding process electrode. Discard the old salt bridge.
2. Replace the standard cell buffer in the chamber of the standard cell. The buffer may be a solution or a gel.
   A. For Solution-Filled Chamber
      a. Pour out the aged standard cell buffer. Thoroughly flush standard electrode chamber with distilled water.
      b. Fill standard electrode chamber with fresh standard cell buffer (GLI p/n 25M1A1001-115).
   B. For Gel-Filled Chamber:
      a. Remove aged standard cell buffer using a jet of water from a "water pik" type device. Thoroughly flush standard electrode chamber with distilled water after removing the gel.
      b. Place one level bottle cap (1/8 level teaspoon) of gel powder (GLI p/n 25M8A1002-101) into chamber. Then add fresh standard cell buffer (GLI p/n 25M1A1001-115). Mix together until a gel consistency is attained. Continue this procedure until

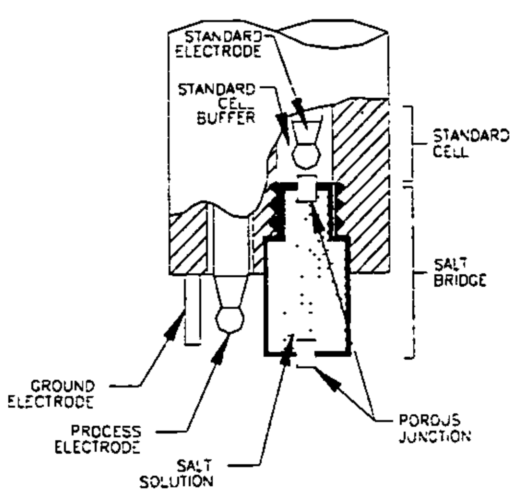


FIGURE 4-1 Sensor Electrode Details

685 305

level of gel is sufficient to contact the salt bridge when it is installed. To check for proper level, replace and remove the salt bridge. A formed impression of the salt bridge should appear in the gel surface.

3. Install the new salt bridge (see Part Five for part number). Inspect O-ring for imperfections and replace if necessary. Turn salt bridge clockwise until finger tight. Then tighten with a 9/16" socket or nut driver (approximately 1/4 turn). **Do not overtighten!**

SECTION 3 - TROUBLESHOOTING

A few simple measurements can determine if the sensor is operating properly. A multimeter and two pH buffer solutions (pH 7 and pH 4 or 10) are required.

Clean the sensor in accordance with Part Four, Section 1. If the instrument and sensor cannot be calibrated, replace the standard cell buffer and salt bridge as described in Part Four, Section 2. If the measuring system still cannot be calibrated after replacing the standard cell buffer and salt bridge, perform the appropriate test in this section (3.1 or 3.2) that applies to your sensor type.

3.1 Sensors With 5-Wire Cable (Integral Preamplifier)

1. Disconnect sensor's red, green, yellow and black wires from the instrument (at junction box, if used) and place sensor in pH 7 buffer. Before performing steps 2 through 5, allow temperature of sensor and buffer solution to equalize at approximately 25°C (room temperature).
2. To verify that the sensor's temperature compensator is operating properly, measure the resistance between the yellow and black wires. The reading should be between 250 and 350 ohms at approximately 25°C.
3. Reconnect the yellow and black wires.
4. Place multimeter (+) lead on red wire and (-) lead on green wire. Measure the DC millivolts with the sensor in pH 7 buffer. This reading is called "offset" and it should be between (-)50 and (+)50 mV. If it is, the sensor "offset" is within factory-specified limits. Note the millivolt value and perform step 5. If not, discontinue this test and refer to GLI's warranty/replacement plan on page 2 for details on sensor replacement.
5. Check the sensor "span" by measuring the millivolts with the sensor in either pH 4 or pH 10 buffer. Keep the millivolt meter connected as described in step 4.

685 306

A. Span Check In pH 4 Buffer

Rinse sensor with water and place in pH 4 buffer. The "span" reading should be at least (+)160 mV more than the noted "offset" reading in step 4. Examples of typical readings are:

"Offset" Reading In pH 7 Buffer	"Span" Reading In pH 4 Buffer
(-)50 mV	(+)110 mV
(-)25 mV	(+)135 mV
0 mV	(+)160 mV
(+)25 mV	(+)185 mV
(+)50 mV	(+)210 mV

B. Span Check In pH 10 Buffer

Rinse sensor with water and place in pH 10 buffer. The "span" reading should be at least (-)160 mV less than the noted "offset" reading in step 4. Examples of typical readings are:

"Offset" Reading In pH 7 Buffer	"Span" Reading In pH 10 Buffer
(-)50 mV	(-)210 mV
(-)25 mV	(-)185 mV
0 mV	(-)160 mV
(+)25 mV	(-)135 mV
(+)50 mV	(-)110 mV

If the "span" reading complies with A or B of this step, the sensor is within factory-specified limits. If not, refer to GLI's warranty/replacement plan on page 2 for details on sensor replacement.

3.2 Sensors With 2-Wire Cable (Integral Two-Wire Transmitter)

1. Connect a DC milliammeter in series with the sensor and the instrument (or +24 VDC source):

   A. Disconnect the sensor's red (+) wire from instrument and connect it to milliammeter (+) input.

   B. Connect the milliammeter (-) input to instrument's (+) input terminal.

2. Place sensor in pH 7 buffer. Allow temperature of sensor and buffer solution to equalize at approximately 25°C (room temperature). Read and note the mA value. This reading is called the "offset" and it should be between 11 and 13 mA. If it is, the sensor "offset" is within factory-specified limits and the sensor "span" should now be

685 307

checked using step 3. If not, discontinue this test and refer to GLI's warranty/replacement plan on page 2 for details on sensor replacement.

3. Check the sensor "span" by measuring the mA value with the sensor in either pH 4 or pH 10 buffer. Keep the milliammeter connected as described in step 1.

   A. Span Check in pH 4 buffer

      Rinse sensor with water and place in pH 4 buffer. Allow temperature of sensor and buffer solution to equalize at 25°C (room temperature). The "span" reading should be 2.37 to 3.10 mA **lower than** the noted "offset" reading in step 2.

      Example: Suppose "offset" reading in pH 7 buffer is 11.50 mA. Then the "span" reading in pH 4 buffer must be between 8.40 and 9.13 mA to be within factory-specified limits.

   B. Span Check In pH 10 buffer

      Rinse sensor with water and place in pH 10 buffer. Allow temperature of sensor and buffer solution to equalize at 25°C (room temperature). The "span" reading should be 2.37 to 3.10 mA **higher than** the noted "offset" reading in step 2.

      Example: Suppose "offset" reading in pH 7 buffer is 11.50 mA. Then the "span" reading in pH 10 buffer must be between 13.87 and 14.60 mA to be within factory-specified limits.

   If the calculated "span" reading conforms with the limits in A or B of this step, the sensor is operating properly. If not, refer to GLI's warranty/replacement plan on page 2 for details on sensor replacement.

3.3 Customer Assistance

Should service, parts or assistance in troubleshooting or repair be required, please contact your GLI representative or the GLI Customer Service Department:

Great Lakes Instruments, Inc.
9020 West Dean Road
Milwaukee, Wisconsin 53224
Telephone: 414/355-3601
Telefax: 414/355-8346

— SERVICE HOURS —

	Eastern Std. Time	Central Std. Time	Mountain Std. Time	Pacific Std. Time
Monday through Thursday	8:30 a.m. to 5:30 p.m	7:30 a.m. to 4:30 p.m.	6:30 a.m. to 3:30 p.m.	5:30 a.m. to 2:30 p.m.
Friday	8:30 a.m. to 4:00 p.m	7:30 a.m. to 3:00 p.m.	6:30 a.m. to 2:00 p.m.	5:30 a.m. to 1:00 p.m.

When ordering spare or replacement parts, be sure to use the **complete** assembly part number.

All sensors returned for repair, freight prepaid, should also include the following information:

1. A clearly written description of the malfunction.
2. Name of person to contact and the phone number where they can be reached.
3. Proper return address for shipping sensor(s) back. Include preferred shipping method (UPS, Federal Express, etc.) if applicable.
4. A purchase order if sensor(s) is out of warranty to cover costs of repair.

NOTE: *If the sensor is damaged during return shipment as a result of inadequate packaging, the customer assumes responsibility for repair costs. It is recommended to use the original GLI carton or an equivalent. Also, GLI will not accept sensors returned for repair or replacement unless they are thoroughly cleaned and all process material is removed.*

PART FIVE - SPARE PARTS AND ACCESSORIES

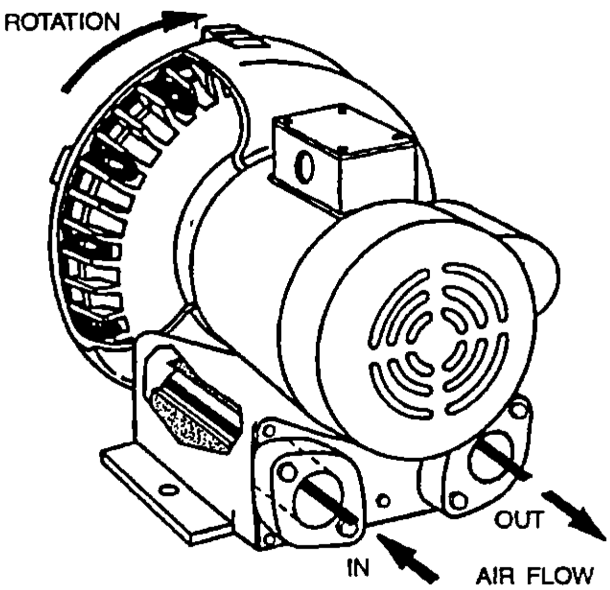
	Description	Part Number
Sensor Accessories	Protector (for submersion applications)	60A2F1278
	Union Adapter Assembly (includes two Viton O-rings and a retaining ring)	60M2G9753-101
	Replacement Viton O-rings (two, for union adapter ass'y)	99X5H1233
Standard Cell Supplies	Standard Cell Buffer (1 pint)	25M1A1001-115
	Gel Powder (for gelling standard cell buffer, 2 grams)	25M8A1002-101
	Salt Bridge (includes O-ring)	60-9765-000*
	Salt Bridge O-ring	99X5H1261
pH Buffers For Calibration And Operation Checks	pH 7 Buffer (1 pint)	99X3A0421
	pH 4 Buffer (1 pint)	99X3A0422
	pH 10 Buffer (1 pint)	99X3A0942

*Some applications require a special salt bridge (identified with a different dash number). When ordering, specify the complete salt bridge number including the dash number.

GROUNDWATER TREATMENT SYSTEM

- **Air Stripper (Not Available)**
- **Air Blower**
- **Air Stripper Sump Pump**
- **Bag Filter**
- **Carbon Adsorber (Not Available)**
- **Sump Pump**
- **Programmable Logic Controller (PLC)**
- **Autodialer**
- **Level Switch (see Flow Equalization System)**
- **Solenoid Valve (Not Available)**
- **Photohelic Gauge**
- **Totalizer/Flow Monitor (see Groundwater Recovery System)**
- **Flow Sensor (see Groundwater Recovery System)**
- **Pressure Switches**
- **Flow Switch**
- **Turbine Flow Meter**

Regenerative Principle



The impeller blades passing the inlet port draw air or other gasses into the blower. The impeller blades then, by centrifugal action, accelerate the air outward and forward. Here the "regenerative" principle takes effect as the air is turned back by the annular shaped housing to the base of the following blades where it is again hurled outward. Each "regeneration" imparts more pressure to the air. When the air reaches the stripper section at the outlet (the stripper is the part of the blower located between the inlet and the outlet in which the annulus is reduced in size to fit closely to the sides and tips of the impeller blades) the air is "stripped" from the impeller and diverted out of the blower. The pressures or vacuums generated by the one or two spinning, non-contacting, oil-free impellers are equal to those obtained by many larger multi-stage or positive displacement blowers.

Blower Features and Benefits

DR (Domestic Regenerative)

Our industrial DR regenerative blowers include:

- Rugged cast aluminum housing, cover, impeller and muffler tower
- Removable cast iron flanges bolted to a sheet metal manifold
- TEFC motors on single-ended models, ODP motors on all double-ended models
- Carbon steel shaft and zinc plated hardware
- Permanently sealed motor bearings for 20,000-25,000 hours life

EN (Environmental Regenerative)

Our explosion-proof EN blowers are designed the same as the DR blowers, except added features include:

- Heavy duty cast aluminum manifold
- Our spark resistant housing, cover, impeller, muffler tower and manifold are vacuum impregnated
- Teflon lip seal in a stainless steel case standard for leakage containment to 5 cc/min or less
- Explosion-proof motors standard and available in a variety of world voltages
- All metal-to-metal surfaces are sealed with RTV sealant

CP (Chemical Processing Regenerative)

Our chemical processing/specialty gas CP blowers are designed the same as DR/EN blowers except added features include:

- Chem-Tough™ surface conversion corrosion resistant treatment for all castings
- Teflon lip seal in a stainless steel case standard for leakage containment to 5 cc/min or less
- Chemical duty motors with 303 stainless steel motor shafts
- Stainless steel hardware throughout
- Nickel plated flanges and muffler retainers

685 312

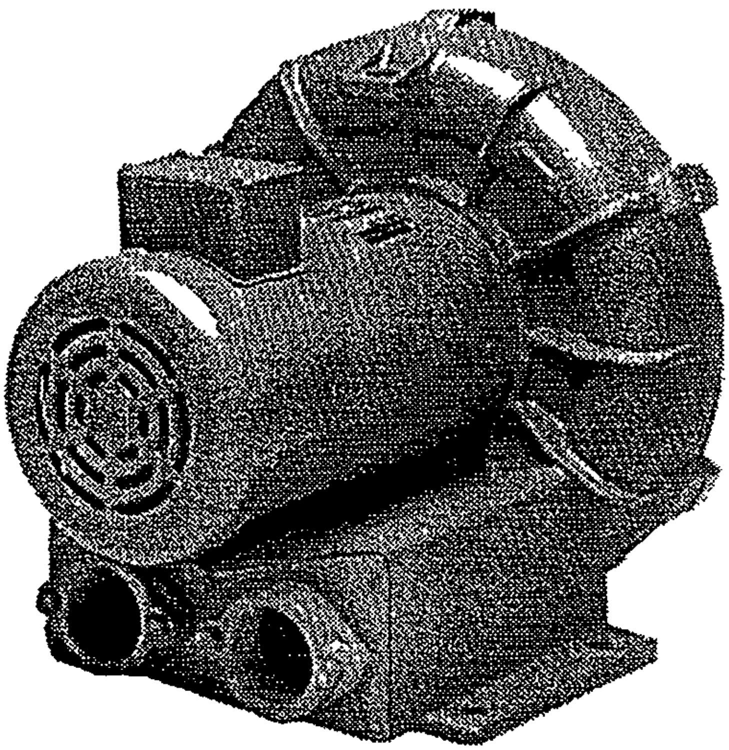
DR 606 & CP 606 Regenerative Blower

FEATURES
- Manufactured in the USA – ISO 9001 compliant
- CE compliant – Declaration of Conformity on file
- Maximum flow: 200 SCFM
- Maximum pressure: 100 IWG
- Maximum vacuum: 6.1" Hg (83 IWG)
- Standard motor: 4.0 HP, TEFC
- Cast aluminum blower housing, impeller & cover; cast iron flanges (threaded)
- UL & CSA approved motor with permanently sealed ball bearings
- Inlet & outlet internal muffling
- Quiet operation within OSHA standards

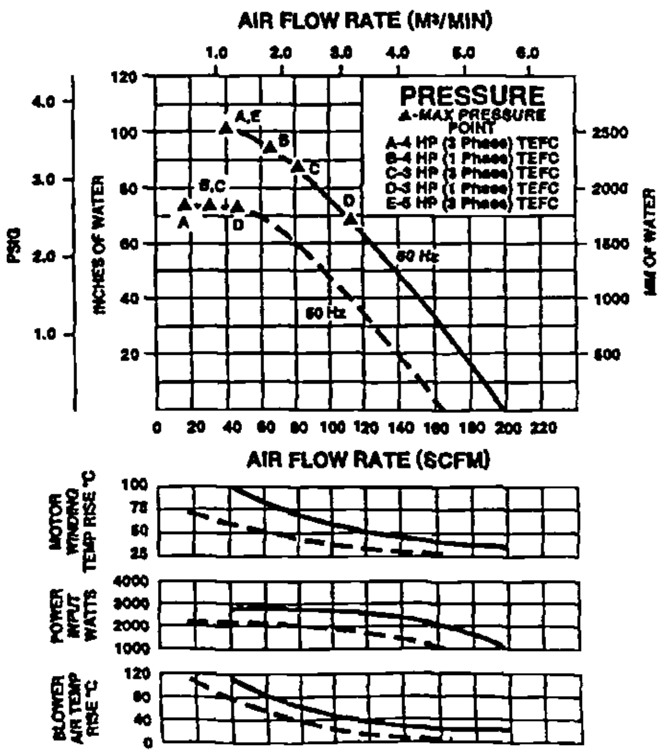
MOTOR OPTIONS
- International voltage & frequency (Hz)
- Chemical duty, high efficiency, inverter duty or industry-specific designs
- Various horsepowers for application-specific needs

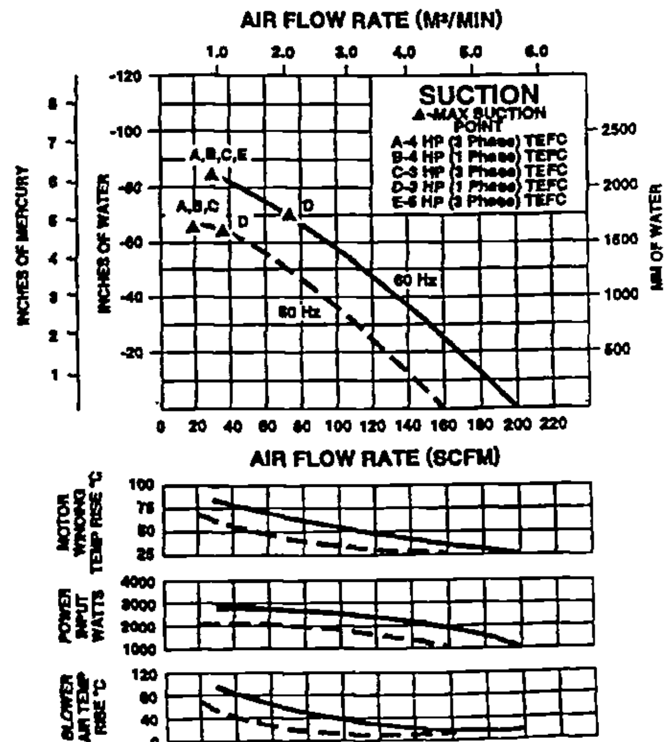
BLOWER OPTIONS
- Corrosion resistant surface treatments & sealing options
- Remote drive (motorless) models
- Slip-on or face flanges for application-specific needs

ACCESSORIES (See Catalog Accessory Section)
- Flowmeters reading in SCFM
- Filters & moisture separators
- Pressure gauges, vacuum gauges & relief valves
- Switches – air flow, pressure, vacuum or temperature
- External mufflers for additional silencing
- Air knives (used on blow-off applications)
- Variable frequency drive package



BLOWER PERFORMANCE AT STANDARD CONDITIONS

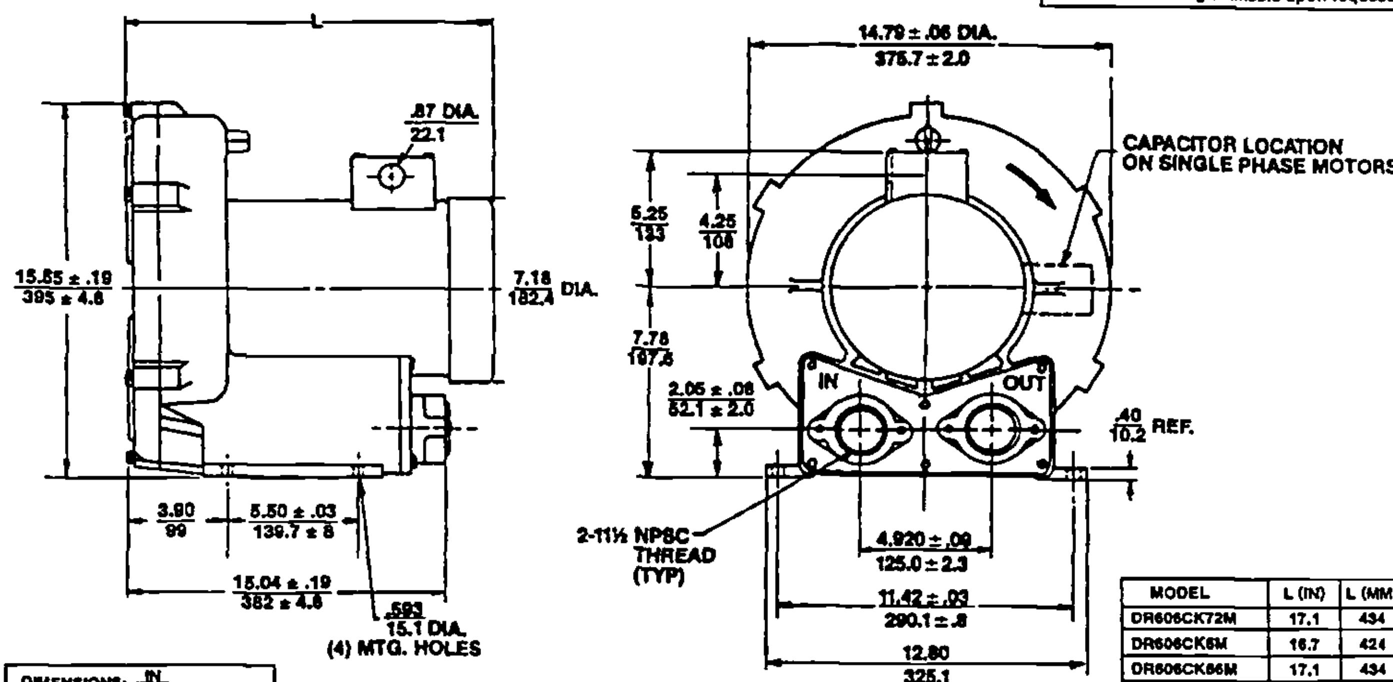




AMETEK Rotron TMD

DR 606 & CP 606 Regenerative Blower

Scale CAD drawing available upon request.



MODEL	L (IN)	L (MM)
DR606CK72M	17.1	434
DR606CK5M	16.7	424
DR606CK86M	17.1	434
DR606K72M	15.8	401
DR606K58M	17.1	434
CP606CR72MLR	16.7	424

DIMENSIONS: $\frac{IN}{MM}$
TOLERANCES: .XX ± $\frac{.06}{2}$
(UNLESS OTHERWISE NOTED)

SPECIFICATIONS

MODEL	DR606CK72M	DR606CK5M	DR606CK86M	DR606K72M	DR606K58M	DR606D72M	CP606CR72MLR
Part No.	038526	038532	038530	038527	038529	080077	038247
Motor Enclosure – Shaft Material	TEFC – CS	TEFC – CS	TEFC – CS	TEFC – CS	TEFC – CS	TEFC – CS	Chem TEFC – SS
Horsepower	4	4	4	3	3	5	Same as DR606CK72M – 038526 except add Chemical Processing (CP) features from catalog inside front cover
Voltage [1]	230/460	230	575	230/460	115/230	208-230/460	
Phase – Frequency [1]	Three - 60 Hz	Single - 60 Hz	Three - 60 Hz	Three - 60 Hz	Single - 60 Hz	Three - 60 Hz	
Insulation Class [2]	F	F	F	F	F	F	
NEMA Rated Motor Amps	10.4/5.2	17.4	4.1	7.6/3.8	24.9/12.4	14-12.8/6.4	
Service Factor	1.0	1.0	1.0	1.15	1.0	1.15	
Locked Rotor Amps	94/47	121	80	88/44	194/97	96/48	
Max. Blower Amps [3]	11.4/5.7	18	4.56	9.5/4.75	27.8/13.9	11-10/5	
Recommended NEMA Starter Size	1/0	2	0	0/0	1.5/1	1/1	
Shipping Weight	98 lb (45 kg)	106 lb (48 kg)	92 lb (42 kg)	96 lb (44 kg)	98 lb (45 kg)	98 lb (45 kg)	

[1] Rotron motors are designed to handle a broad range of world voltages and power supply variations. Our dual voltage 3 phase motors are factory tested and certified to operate on both: **208-230/415-460 VAC-3 ph-60 Hz** and **190-208/380-415 VAC-3 ph-50 Hz**. Our dual voltage 1 phase motors are factory tested and certified to operate on both: **104-115/208-230 VAC-1 ph-60 Hz** and **100-110/200-220 VAC-1 ph-50 Hz**. All voltages above can handle a ±10% voltage fluctuation. Special wound motors can be ordered for voltages outside our certified range.

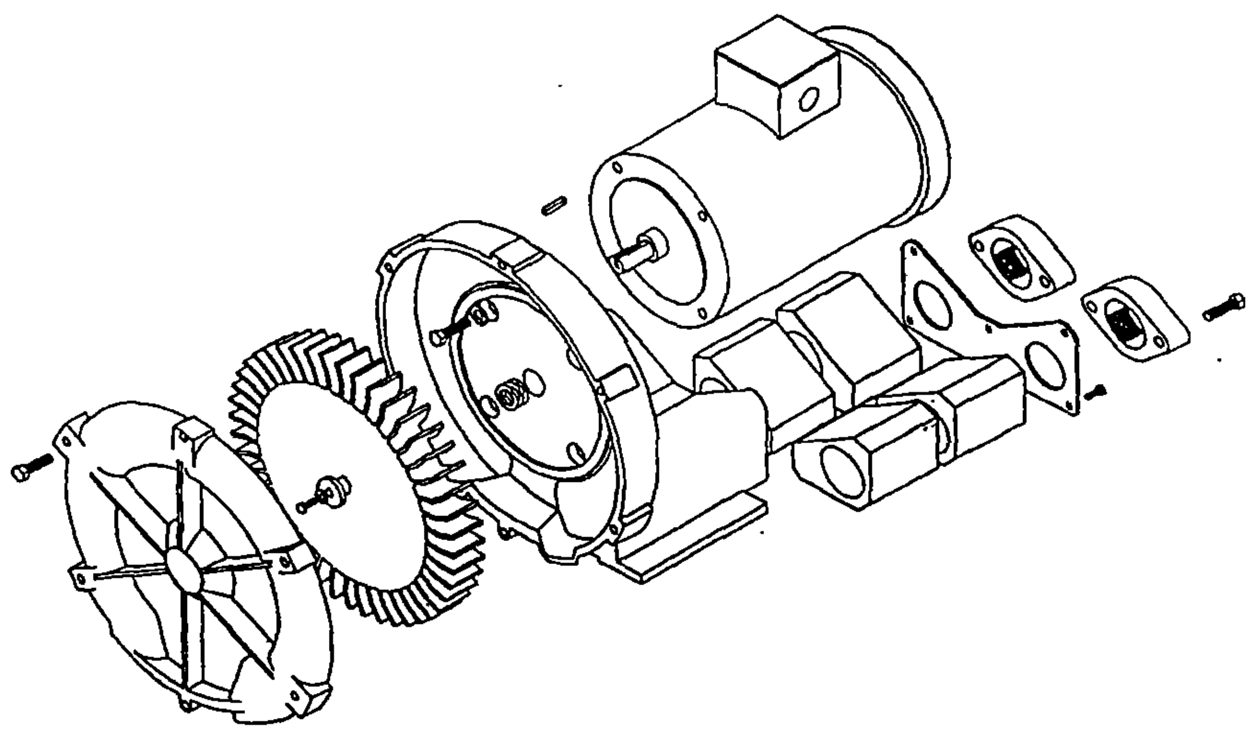
[2] Maximum operating temperature: Motor winding temperature (winding rise plus ambient) should not exceed 140°C for Class F rated motors or 120°C for Class B rated motors. Blower outlet air temperature should not exceed 140°C (air temperature rise plus inlet temperature) Performance curve maximum pressure and suction points are based on a 40°C inlet and ambient temperature. Consult factory for inlet or ambient temperatures above 40°C.

[3] Maximum blower amps corresponds to the performance point at which the motor or blower temperature rise with a 40°C inlet and/or ambient temperature reaches the maximum operating temperature.

Specifications subject to change without notice. Please consult your Local Field Sales Engineer for specification updates.

685 314

Service and Parts Manual for Blower Model DR404 - DR606



AMETEK®
ROTRON TECHNICAL MOTOR DIVISION
REGENERATIVE BLOWER GROUP
SAUGERTIES, NEW YORK 12477
TEL (914) 246-3401 FAX (914) 246-3802

685 315

WARRANTY, INSTALLATION, MAINTENANCE AND TROUBLESHOOTING INSTRUCTIONS

AMETEK

ROTRON TECHNICAL MOTOR DIVISION
Industrial Products
75 North Street, Saugerties, NY 12477 U.S.A.
Telephone: 914-246-3401 Fax: 914-246-3802

1. **No Fault Policy** - AMETEK Rotron DR, EN and HiE regenerative direct drive blowers are guaranteed for one full year from the date of installation (limited to 18 months from the date of shipment.) to the original purchaser only. Should the blower fail, **regardless of the cause of failure**, we will at our option repair or replace the blower.

2. **Standard Policy** - AMETEK Rotron Minispiral, Revaflow, Multiflow, Nautilair, remote drive blowers, moisture separators, packaged units, CP blowers, Nasty Gas™ models and special built (EO) products are guaranteed for one full year from date of shipment for workmanship and material defect to the original purchaser only. Should the blower fail, we will evaluate the failure. If failure is determined to be workmanship or material defect related, we will at our option repair or replace the blower.

3. **Parts Policy** - AMETEK Rotron spare parts and accessories are guaranteed for three months from date of shipment for workmanship and material defect to the original purchaser only. If failure is determined to be workmanship or material defect related we will at our option repair or replace the part.

Corrective Action - A written report will be provided indicating reason(s) for failure, with suggestions for corrective action. Subsequent customer failures due to abuse, misuse, misapplication or repeat offense will not be covered. AMETEK Rotron will then notify you of your options. Any failed unit that is tampered with by attempting repair or diagnosis will void the warranty, unless authorized by the factory.

Terms and Conditions - Our warranty covers repairs or replacement of regenerative blowers only, and will not cover labor for installation, outbound and inbound shipping costs, accessories or other items not considered integral blower parts. Charges may be incurred on products returned for reasons other than failures covered by their appropriate warranty. Out-of -warranty product and in warranty product returned for failures determined to be caused by abuse, misuse, or repeat offense will be subject to an evaluation charge. Maximum liability will in no case exceed the value of the product purchased. Damage resulting from mishandling during shipment is not covered by this warranty. It is the responsibility of the purchaser to file claims with the carrier. Other terms and conditions of sale are stated on the back of the order acknowledgement.

Installation Instructions for SL, DR, EN, CP, and HiE Series Blowers

1. **Bolt It Down** - Any blower must be secured against movement prior to starting or testing to prevent injury or damage. The blower does not vibrate much more than a standard electric motor.

2. **Filtration** - All blowers should be filtered prior to starting. Care must be taken so that no foreign material enters the blower. If foreign material does enter the blower, it could cause internal damage or may exit at extremely high velocity.

685 316

Should excessive amounts of material pass through the blower, it is suggested that the cover(s) and impeller(s) be removed periodically and cleaned to avoid impeller imbalance. Impeller imbalance greatly speeds bearing wear, thus reducing blower life. Disassembling the blower will void warranty, so contact the factory for cleaning authorization.

3. **Support the Piping** - The blower flanges and nozzles are designed as connection points only and are not designed to be support members.

   Caution: Plastic piping should not be used on blowers larger than 1 HP that are operating near their maximum pressure or suction point. Blower housing and nearby piping temperatures can exceed 200°F. Access by personnel to the blower or nearby piping should be limited, guarded, or marked, to prevent danger of burns.

4. **Wiring** - Blowers must be wired and protected/fused in accordance with local and national electrical codes. All blowers must be grounded to prevent electrical shock. Slo-Blo or time delay fuses should be used to bypass the first second of start-up amperage.

5. **Pressure/Suction Maximums** - The maximum pressure and/or suction listed on the model label should not be exceeded. This can be monitored by means of a pressure or suction gage (available from Rotron), installed in the piping at the blower outlet or inlet. Also, if problems do arise, the Rotron Field representative will need to know the operating pressure/suction to properly diagnose the problem.

6. **Excess Air** - Bleed excess air off. DO NOT throttle to reduce flow. When bleeding off excess air, the blower draws less power and runs cooler.

   Note: Remote Drive (Motorless) Blowers - Properly designed and installed guards should be used on all belts, pulleys, couplings, etc. Observe maximum remote drive speed allowable. Due to the range of uses, drive guards are the responsibility of the customer or user. Belts should be tensioned using belt gauge.

Maintenance Procedure

When properly piped, filtered, and applied, little or no routine maintenance is required. Keep the filter clean. Also, all standard models in the DR, EN, CP, and HiE series have sealed bearings that require no maintenance. Bearing should be changed after 15,000 to 20,000 hours, on average. Replacement bearing information is specified on the chart below.

Bearing Part Number	Size	Seal Material	Grease	Heat Stabilized
510217 510218 510219	205 206 207	Polyacrylic	Nye Rheotemp 500 30% +/- 5% Fill	Yes – 325 F
510449 516440 516648	203 202 307	Buna N	Shell Dolium "R" 25-40% Fill	NO
516840 516841 516842 516843 516844 516845 516846 516847	206 207 208 210 309 310 311 313	Buna N	Shell Dolium "R" 30%+/- 5% Fill	NO

Troubleshooting

		POSSIBLE CAUSE	OUT OF WARRANTY REMEDY ***
IMPELLER DOE NOT TURN	Humming Sound	1. * One phase of power line not connected	1. Connect
		2. * One phase of stator winding open	2. Rewind or buy new motor
		3. Bearings defective	3. Change bearings
		4. Impeller jammed by foreign material	4. Clean and add filter
		5. Impeller jammed against housing or cover	5. Adjust
		6. ** Capacitor open	6. Change capacitor
	No Sound	1. * Two phases of power line not connected	1. Connect
		2. * Two phases of stator winding open	2. Rewind or buy new motor
IMPELLER TURNS	Blown Fuse	1. Insufficient fuse capacity	1. Use time delay fuse of proper rating
		2. Short circuit	2. Repair
	Motor Overheated Or Protector Trips	1. High or low voltage	1. Check input voltage
		2. * Operating in single phase condition	2. Check connections
		3. Bearings defective	3. Check bearings
		4. Impeller rubbing against housing or cover	4. Adjust
		5. Impeller or air passage clogged by foreign material	5. Clean and add filter
		6. Unit operating beyond performance range	6. Reduce system pressure/vacuum
		7. Capacitor shorted	7. Change capacitor
		8. * One phase of stator winding short circuited	8. Rewind or buy new motor
	Abnormal Sound	1. Impeller rubbing against housing or cover	1. Adjust
		2. Impeller or air passages clogged by foreign material	2. Clean and add filter
		3. Bearings defective	3. Change bearings
	Performance Below Standard	1. Leak in piping	1. Tighten
		2. Piping and air passages clogged	2. Clean
		3. Impeller rotation reversed	3. Check wiring
		4. Leak in blower	4. Tighten cover, flange
		5. Low voltage	5. Check input voltage

* 3 phase units

** 1 phase units

*** Disassembly and repair of new blowers or motors will void the Rotron warranty. Factory should be contacted prior to any attempt to field repair an in-warranty unit.

Blower Disassembly:

WARNING: Attempting to repair or diagnose a blower may void Rotron's warranty. It may also be difficult to successfully disassemble and reassemble the unit.

1) Disconnect the power leads. **CAUTION:** Be sure the power is disconnected before doing any work whatsoever on the unit.

2) Remove or separate piping and/or mufflers and filters from the unit.

3) Remove the cover bolts and then the cover. **NOTE:** Some units are equipped with seals. It is mandatory that these seals be replaced once the unit has been opened.

4) Remove the impeller bolt and washers and then remove the impeller. **NOTE:** Never pry on the edges of the impeller. Use a puller as necessary.

5) Carefully note the number and location of the shims. Remove and set them aside. NOTE: If the disassembly was for inspection and cleaning the unit may now be reassembled by reversing the above steps. If motor servicing or replacement and/or impeller replacement is required the same shims may not be used. It will be necessary to re-shim the impeller according to the procedure explained under assembly.

6) Remove the housing bolts and remove the motor assembly (arbor/.housing on remote drive models).

7) Arbor disassembly (Applicable on remote drive models only):
   a) Slide the bearing retraining sleeve off the shaft at the blower end.
   b) Remove the four (4) screws and the bearing retaining plate from the blower end.
   c) Lift the shaft assembly far enough out of the arbor to allow removal of the blower end snap ring.
   d) Remove the shaft assembly from the arbor.
   e) If necessary, remove the shaft dust seal from the pulley end of the arbor.

Muffler Material Replacement:

1) Remove the manifold cover bolts and them manifold cover.

2) The muffler material can now be removed and replaced if necessary. On blowers with fiberglass acoustical wrap the tubular retaining screens with the fiberglass matting before sliding the muffler pads over the screens.

3) Reassemble by reversing the procedure.

NOTE: On DR068 models with tubular mufflers it is necessary to remove the cover and impeller accessing the muffler material from the housing cavity.

Blower Reassembly:

1) Place the assembled motor (assembled arbor assembly for remote drive models) against the rear of the housing and fasten with the bolts and washer.

2) To ensure the impeller is centered within the housing cavity re-shim the impeller according to the procedure outlined below.

3) If blower had a seal replace the seal with a new one.

4) Place the impeller onto the shaft making sure the shaft key is in place and fasten with the bolt, washer and spacer as applicable. Torque the impeller bolt per the table below. Once fastened carefully rotate the impeller to be sure it tums freely.

5) Replace the cover and fasten with bolts.

6) Reconnect the power leads to the motor per the motor nameplate.

Bolt Size	Torque
1/4-20	6.25 +/- 0.25
5/16-18	11.5 +/- 0.25
3/8-16	20.0 +/- 0.5
½-13	49.0 +/- 1
5/8 –11	90.0 +/- 2

Impeller Shimming Procedure:

WARNING: This unit may be difficult to shim. Extreme care may be exercised.

Tools Needed: Machinist's Parallel Bar
Vernier Caliper with depth measuring capability
Feeler gauges or depth gauge

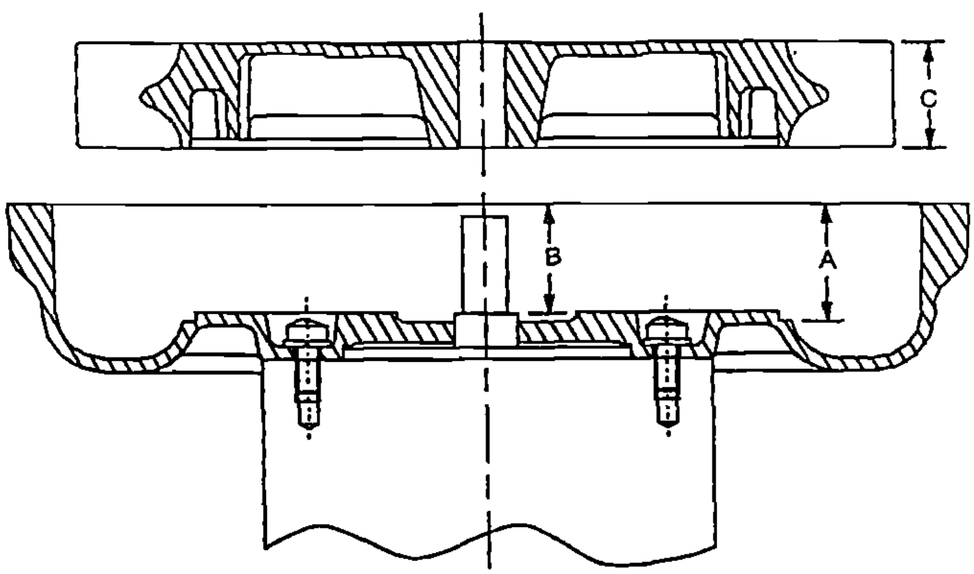
Measure the Following:

Distance from the flange face to the housing (A)
Distance from the flange face to the motor shaft shoulder (B)
Impeller Thickness (C)

Measurements (A) and (B) are made by laying the parallel bar across the housing flange face and measuring to the proper points. Each measurement should be made at three points, and the average of the readings should be used.

Shim Thickness = B – (A+C)/2

After the impeller installation (step #4 above) the impeller/cover clearance can be checked with feeler gauges, laying the parallel bar across the housing flange face. This clearance should nominally be (A+C)/2.



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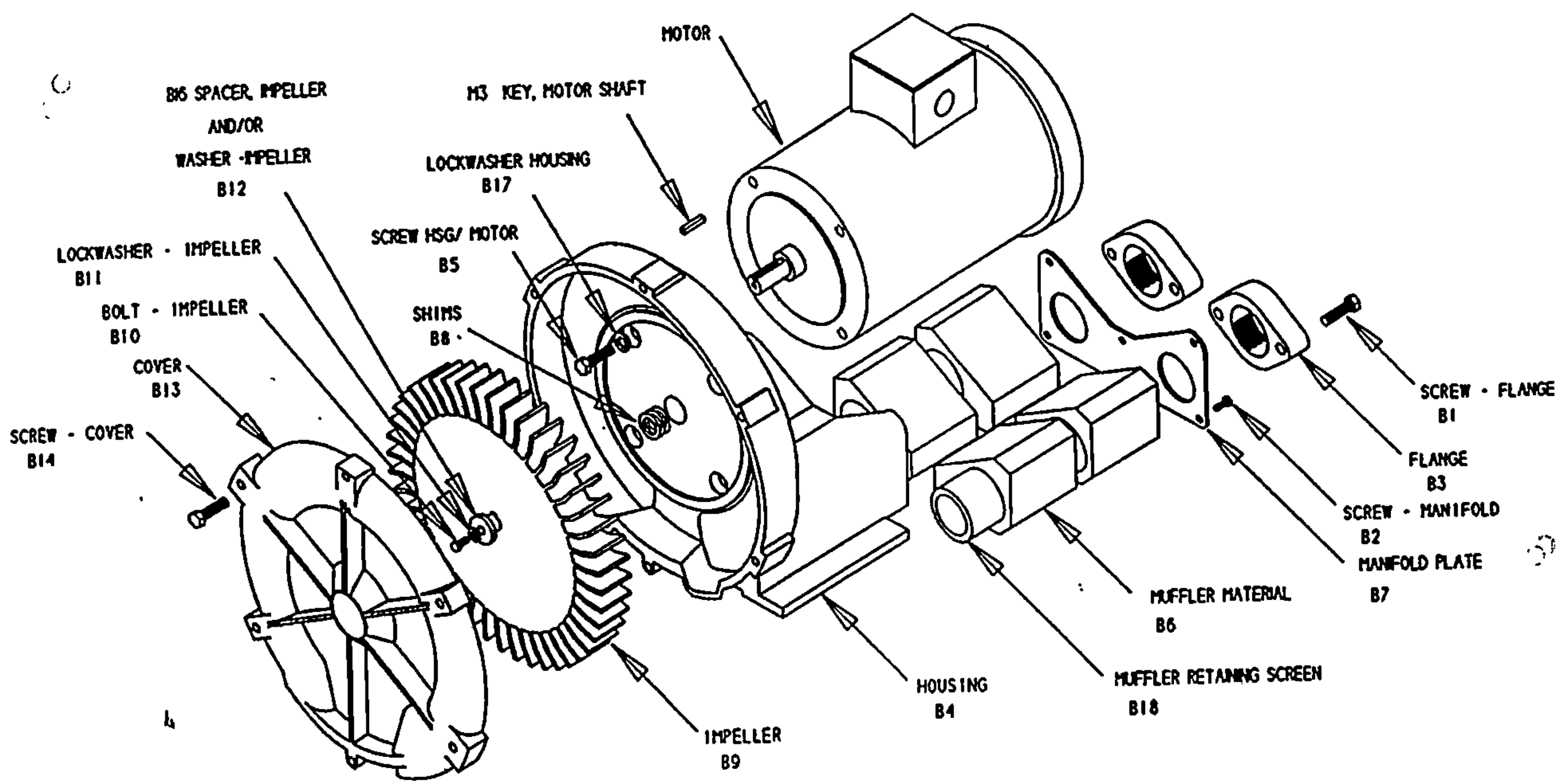
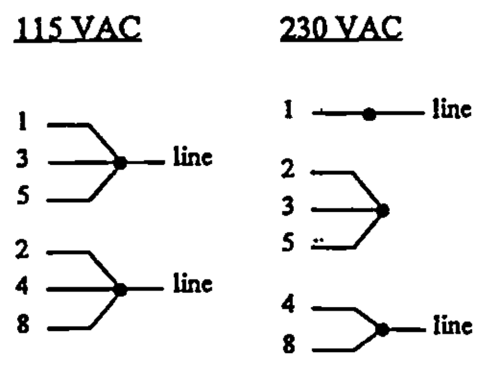
ASSEMBLY DIAGRAM
DR XOX



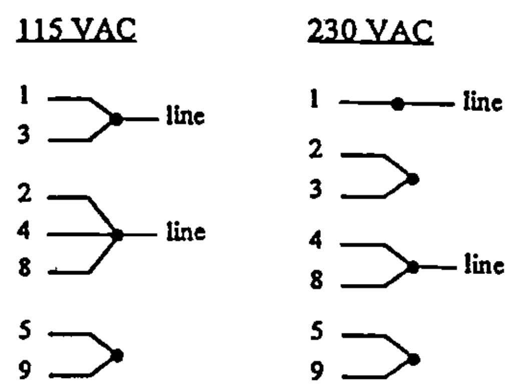
Wiring Diagrams, TEFC and ODP Motors

A. 1ø, 6 wire



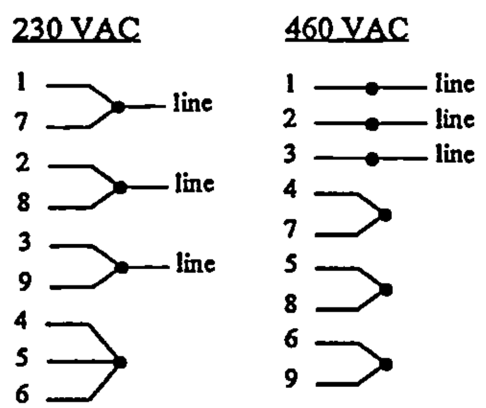
Interchange leadwires 5 & 8 to reverse rotation

B. 1ø, 7 wire



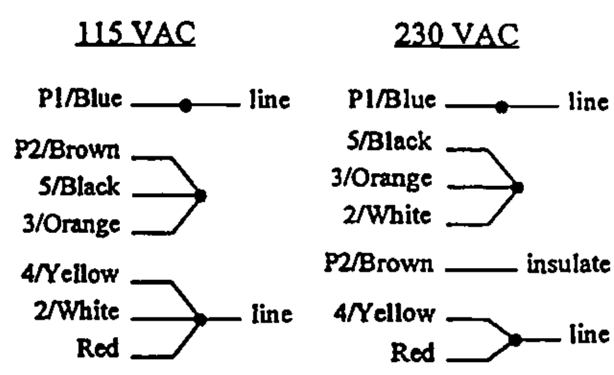
Interchange leadwires 5 & 8 to reverse rotation

C. 3ø, 9 wire



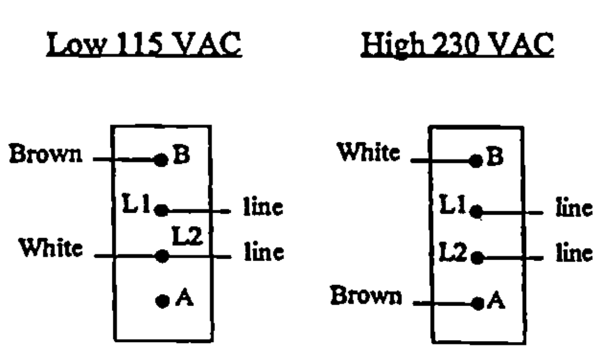
Interchange any two line leads to reverse rotation

D. 1ø, Emerson 1/8 HP Motor

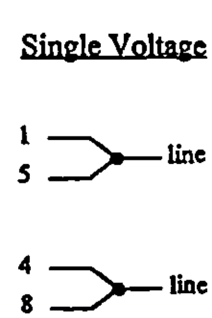


Interchange red & black to reverse rotation

E. 1ø, Spa Duty with Terminal Strips

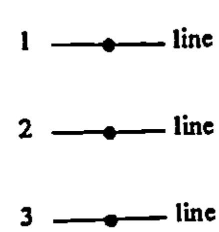


F. 1ø, 230 VAC



Interchange leadwires 5 & 8 to reverse rotation

G. 3ø, 575 VAC



Interchange any two line leads to reverse rotation

685 322

Parts Breakdown

		Model:	**DR404**	**DR454**	**DR513**	**DR523**	**DR505**	**DR555**	**DR606**
		Part No.:	037406 037408 037407	036855 036856 036949 038808	037217 037209 037773	037210 037211 037772	037542 037543 037544 037545 037546	037308 037306 037305 037546 037309	038526 038527 038530 037547 038529 080077
Item No.	**Qty. Req'd**	**Description**							
M3	1	Key Motor Shaft	510629	510629	510629	155099	510629	510629	510629
B1	4	Screw, Flange	120162	120162	120162	120162	120162	120162	120255
B2	6	Screw, Manifold	155130	155477 (10 pcs)	120214 (10 pcs)	120214	155130	155477	155477
B3	2	Flange	510962	510354	510354	510354	510354	510354	511480
B4	1	Housing	517002	515737	516552	516551	517419	516721	529790
B5	4	Screw, Hsg /Motor	155128	251791	251791	251791	155128	251791	251791
B6	4	Muffler Material	(6 pcs) 517015	515743	516560	516560	(6 pcs) 515743	515743	529781
B7	1	Manifold Plate	517008	515744	529868	529868	517456	517458	511284
B8	*	Shim .002"	510356	510356	510356	500664	510356	510356	510356
	*	Shim .005"	510357	510357	510357	500665	510357	510357	510357
	*	Shim .010"	510358	510358	510358	500666	510358	510356	510358
	*	Shim .020"	510359	510359	510359	500667	510359	510359	510359
	*	Shim .030"	Not Used	Not Used	Not Used	510292	Not Used	Not Used	Not Used
B9	1	Impeller	516987	515675	516557 (2 pcs)	516562	517433	516678	511272
B10	1	Bolt, Impeller	120214	120214	120325	120214	120214	120262	120325
B11	1	Lockwasher, Impeller	120203	120203	120203	120203	120203	120203	120203
B12	1	Washer, Impeller	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
B13	1	Cover	516990	515702	516559	516559	517431	516675	511274
B14	6	Screw, Cover	155129	155236 (8 pcs)	120255 (8 pcs)	155098	155236 (7 pcs)	155236	155236
B16	1	Spacer, Impeller Bolt	510355	510355	510355	510355	510355	510355	510355
B17	4	Lockwasher, Housing	251787	251787	251787	Not Used	251787	251787	251787
B18	1	Screen, Muffler Retaining, Right (**)	517016	510362	511718	511718	See Next Page	510362	529782
	1	Screen, Muffler Retaining, Left (**)	517016	510362	511718	511718	See Next Page	510362	529782
B19		Bolt, Muffler Hsg/Hsg	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
B20		Muffler Housing	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
		Bolt, Motor/Muffler	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
		Lockwasher, Motor/Muffler	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
		Washer, Motor/Muffler	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
		Spacer, Motor/Muffler	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
		Lip Seal	Not Used	Not Used	Not Used	516587	Not Used	Not Used	Not Used

eeded **Viewed looking at inlet/outlet ports

Model	Part #	Motor	Wiring Diagram	Specific Parts	Bearing, Rear (M1)	Bearing, Impeller End (M2)
DR404AL72M	037406	510438	C			
DR404AL86M	037408	510700	G		510449	510217
DR404AL58M	037407	510439	A			
DR454R72	036855	510317	C			
DR454R58	036856	510319	A		510449	510217
DR454R86	036949	516034	G			
DR454CD72	038808	510763	C			
DR513R72	037217	510317	C			
DR513R58	037209	510319	A		510449	510217
DR513R86	037773	516034	G			
DR523K72	037210	516571	C	B13A Center		
DR523K58	037211	516572	A	Annulus	510449	510217
DR523K86	037772	522957	G	(1 pc) 516555		
DR505CD58M	037546	510762	A	B18 R517436		
DR505CD72M	037545	510763	C	R517436		
DR505AS86M	037544	510701	G		510449	510217
DR505AS72M	037543	510318	C	B18 R517435		
DR505AS58M	037542	510320	A	R517435		
DR555CK72	037308	510895	C			
DR555K72	037306	511306	C	B2A Washer		
DR555K58	037305	511307	A	Manifold	510449	
DR555CK86	037310	511305	G	(6 pcs) 120222		510217
DR555K86	037309	516686	G			
DR606CK72M	038526	510895	C			
DR606K72M	038527	511306	C			
DR606K58M	038529	511307	A			
DR606CK86M	038530	511305	G		510449	510217
DR606CK5M	038532	516848	F			
DR606D72M	030077	550689	C			

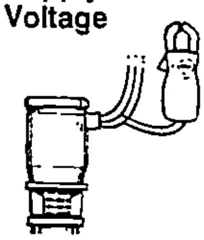
*As needed **Viewed looking at inlet/outlet ports

Troubleshooting

WARNING
WHEN WORKING WITH ELECTRICAL CIRCUITS, USE CAUTION TO AVOID ELECTRICAL SHOCK. IT IS RECOMMENDED THAT RUBBER GLOVES AND BOOTS BE WORN, AND METAL TERMINAL BOXES AND MOTORS ARE GROUNDED BEFORE ANY WORK IS DONE.
FOR YOUR PROTECTION, ALWAYS DISCONNECT THE PUMP FROM ITS POWER SOURCE BEFORE HANDLING.

Preliminary Tests

Supply Voltage



How to Measure

Use a volt meter, (set to the proper scale) measure the voltage at the pump terminal box or starter

On single-phase units, measure between power leads L1 and L2 (or L1 and N for 115 volt units) On three-phase units, measure between.

- Power leads L1 and L2
- Power leads L2 and L3
- Power leads L3 and L1

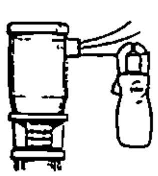
What It Means

When the motor is under load, the voltage should be within ±10% of the nameplate voltage. Larger voltage variation may cause winding damage.

Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected

If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.

Current Measurement



How to Measure

Use an ammeter, (set on the proper scale) to measure the current on each power lead at the terminal box or starter. See the motor nameplate for amp draw information.

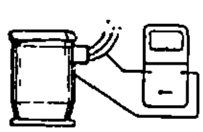
Current should be measured when the pump is operating at constant discharge pressure.

What It Means

If the amp draw exceeds the listed service factor amps (SFA) or if the current imbalance is greater than 5% between each leg on three-phase units, check the following.

1. Burned contacts on motor starter.
2. Loose terminals in starter or terminal box or possible wire defect.
3. Too high or too low supply voltage.
4. Motor windings are shorted or grounded Check winding and insulation resistances.
5. Pump is damaged causing a motor overload

Insulation Resistance



How to Measure

Turn off power and disconnect the supply power leads in the pump terminal box Using an ohm or mega ohm meter, set the scale selector to Rx 100K and zero adjust the meter.

Measure and record the resistance between each of the terminals and ground

What It Means

Motors of all HP, voltage, phase and cycle duties have the same value of insulation resistance Resistance values for new motors must exceed 1,000,000 ohms If they do not, motor should be repaired or replaced.

685 325

Troubleshooting

Diagnosing Specific Problems

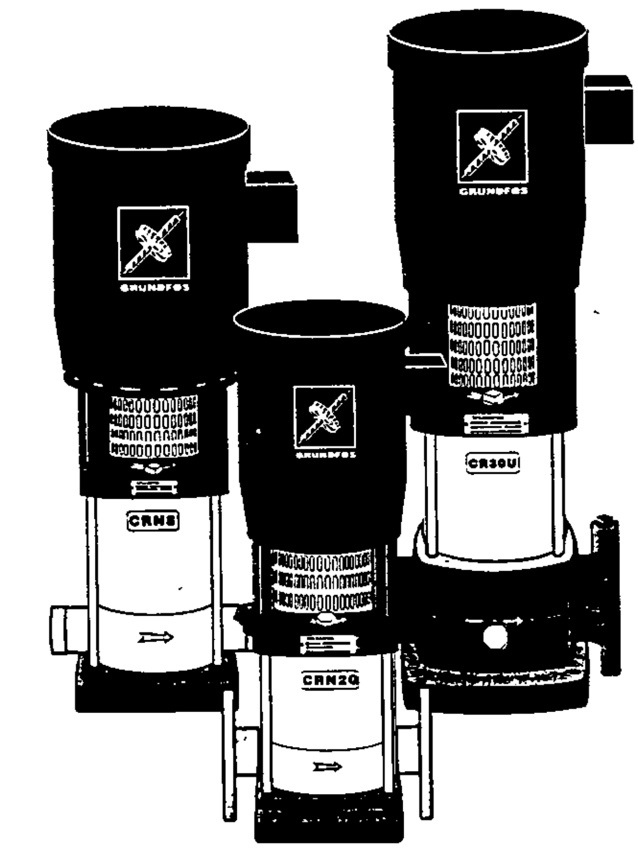
Problem	Possible Cause	Remedy
The pump does not run	1. No power at motor.	Check for voltage at motor teminal box. If no voltage at motor, check feeder panel for tripped circuits and reset circuit.
	2. Fuses are blown or circuit breakers are tripped.	Turn off power and remove fuses. Check for continuity with ohmmeter. Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation, motor and wires must be checked.
	3. Motor starter overloads are burned or have tripped out.	Check for voltage on line and load side of starter. Replace burned heaters or reset. Inspect starter for other damage. If heater trips again, check the supply voltage and starter holding coil.
	4. Starter does not energize.	Energize control circuit and check for voltage at the holding coil. If no voltage, check control circuit fuses. If voltage, check holding coil for shorts. Replace bad coil.
	5. Defective controls.	Check all safety and pressure switches for operation. Inspect contacts in control devices. Replace worn or defective parts or controls.
	6. Motor is defective.	Turn off power and disconnect wiring Measure the lead to lead resistances with ohmmeter (RX-1). Measure lead to ground values with ohmmeter (RX-100K). Record measured values. If an open or grounded winding is found, remove motor and repair or replace.
	7. Defective capacitor. (Single-phase motors)	Turn off power and discharge capacitor. Check with ohmmeter (RX-100K). When the meter is connected to the capacitor, the needle should jump towards 0 ohms and slowly drift back to infinity (∞). Replace if defective.
	8. Pump is bound.	Turn off power and manually rotate pump shaft. If shaft does not rotate easily, check coupling setting and adjust as necessary. If shaft rotation is still tight, remove pump and inspect. Disassemble and repair
The pump runs but at reduced capacity or does not deliver water	1. Wrong rotation	Check wiring for proper connections. Correct wiring.
	2 Pump is not primed or is airbound.	Turn pump off, close isolation valve(s), remove priming plug. Check fluid level. Refill the pump, replace plug and start the pump. Long suction lines must be filled before starting the pump.
	3 Strainers, check or foot valves are clogged	Remove strainer, screen or valve and inspect. Clean and replace. Reprime pump

685 326

Series C

Low-Maintenance Multi-Stage Centrifugal Pumps

Installation and Operating Instructions



Please leave these instructions with the pump for future reference.

GRUNDFOS

"Leaders in Pump Technology"

SAFETY WARNING

Electrical Work

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

Shock Hazard

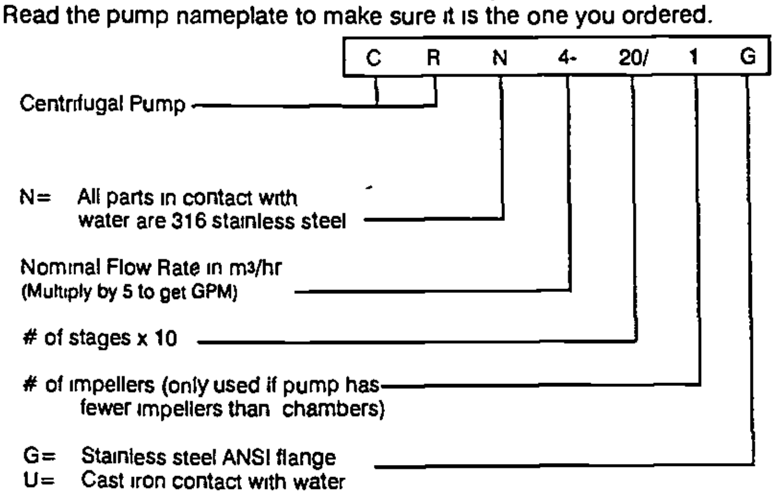
A faulty motor or wiring can cause electrical shock that could be fatal, whether touched directly or conducted through standing water. For this reason, proper grounding of the pump to the power supply's grounding terminal is required for safe installation and operation.

In all installations, the above-ground metal plumbing should be connected to the power supply ground as described in Article 250-80 of the National Electrical Code.

Pre-Installation Checklist

1. Confirm You Have the Right Pump

Read the pump nameplate to make sure it is the one you ordered.



2. Check the Condition of the Pump

The shipping carton your pump came in is specially designed around your pump during production to prevent damage. As a precaution, it should remain in the carton until you are ready to install it. At that point, look at the pump and examine it for any damage that may have occurred during shipping Examine any other parts of the shipment as well for any visible damage.

The position of the coupling (that connects the pump shaft to the motor shaft) is set at factory specifications. No adjustment is required.

685 328

Pre-Installation Checklist

3. Verify Electrical Requirements

Verification of the electrical supply should be made to be certain the voltage, phase and frequency match that of the pump motor. The proper operating voltage and other electrical information can be found on the motor nameplate. These motors are designed to run on ±10% of the nameplate-rated voltage. For dual-voltage motors, the motor should be internally connected to operate on the voltage closest to the 10% rating, i.e., a 208 voltage motor wired per the 208 volt connection diagram. Wiring connection diagrams can be found on the plates attached to the motor. **If voltage variations are larger than ±10%, do not operate the pump.**

4. Is the Application Correct for This Pump ?

Compare the pump's nameplate data or its performance curve with the application in which you plan to install it. Will it perform the way you want it to perform? Also, make sure the application falls within the following limits:

Type	Designed to pump...
CR	Hot and chilled water, boiler feed, condensate return, glycols and solar thermal fluids.
CRN	Deionized, demineralized and distilled water. Brackish water and other liquids unsuitable for contact with iron or copper alloys (Consult manufacturer for specific liquid compatibilities)

Maximum Operation Conditions

Maxium Fluid Temperature (all models). 5° to 250°F (-15° to 121°C)

All motors are designed for continuous duty in 104°F (40°C) ambient. For higher ambient temperature conditions consult Grundfos.

Maximum Working Pressures
(The following pressures are given for fluids at 250°F. Consult Grundfos for other working condtions.)

Pump Type	Models	Max PSI/(Bars)
CR2/CRN2	20 to 100	230/(16)
	120 to 180	300/(20)
CR4/CRN4	20/1 to 100	230/(16)
	120 to 160/14	300/(20)
CR8/CRN8	20/1 to 80	230/(16)
	100 to 160	330/(23)
CR16/CRN16	30/2 to 80	230/(16)
	100 to 120	330/(23)
CR30/CRN30	10 to 50	230/(16)
	80/6 to 110/10	365/(25)
CR60/CRN60	20 to 50	230/(16)
	60 to 80	330/(23)

Installation Procedures

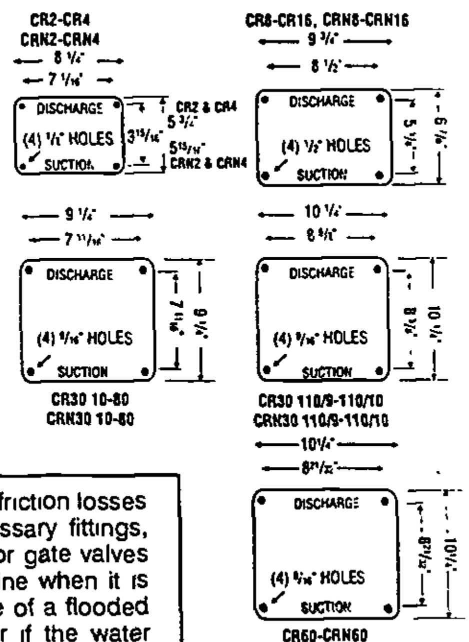
Select Pump Location

The pump should be located in a dry, well-ventilated area which is not subject to freezing or extreme variation in temperature. Care must be taken to ensure the pump is mounted at least 6 inches (150 mm) clear of any obstruction or hot surfaces. The motor requires an adequate air supply to prevent overheating and should not be totally enclosed. For open systems requiring suction lift the pump should be located as close to the water source as possible to reduce piping losses.

Foundation

Concrete or similar foundation material should be used to provide a secure, stable mounting base for the pump. Bolt hole center line dimensions for the various pump types are given in Figure 1. Secure the pump to the foundation using all four bolts and shim pump base to assure the pump is vertical and all four pads on the base are properly supported.

Figure 1
Bolt Hole Centers



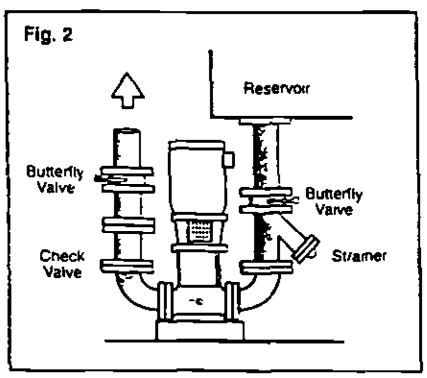
Pipework

Suction Pipe

The suction pipe should be adequately sized and run as straight and short as possible to keep friction losses to a minimum. Avoid using unnecessary fittings, valves or accessory items. Butterfly or gate valves should only be used in the suction line when it is necessary to isolate a pump because of a flooded suction condition. This would occur if the water source is above the pump. See Figures 2 and 3.

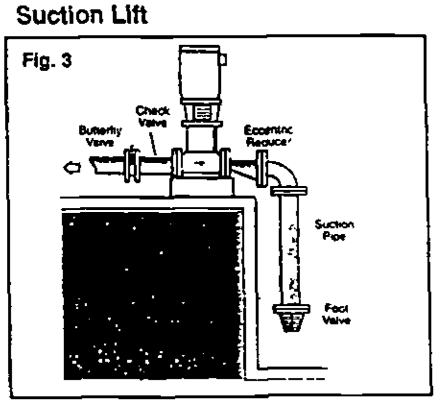
Flooded Suction

Fig. 2



Suction Lift

Fig. 3



685. 330

Installation Procedures

Minimum Suction Pipe Sizes

The following recommended suction pipe sizes are the smallest sizes which should be used with any specific Series C pump type. The suction pipe size should be verified with each installation to ensure good pipe practices are being observed and excess friction losses are not encountered.

CR2	1"	Nominal diameter sch 40 pipe
CR4	1 1/4"	Nominal diameter sch 40 pipe
CR8 & CR16	2"	Nominal diameter sch 40 pipe
CR30	3"	Diameter sch 40 pipe is preferable but 2 1/2" pipe may be
....		used if the pumping rate is less than 88 GPM (20 M3/hr)
CR60	4"	Nominal diameter sch 40 pipe

Discharge Piping

It is suggested that a check valve and isolation valve be installed in the discharge pipe. Pipe, valves and fittings should be at least the same diameter as the discharge pipe or sized in accordance with good piping practices to reduce excessive fluid velocities and pipe friction losses **Pipe, valves and fittings must have a pressure rating equal to or greater than the maximum system pressure.** Before the pump is installed it is recommended that the discharge piping be pressure checked to at least the maximum pressure the pump is capable of generating or as required by codes or local regulations.

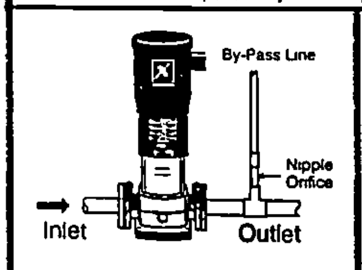
Whenever possible, avoid high pressure loss fittings, such as elbows or branch tees directly on either side of the pump. The piping should be adequately supported to reduce thermal and mechanical stresses on the pump. Good installation practice recommends the system be thoroughly cleaned and flushed of all foreign materials and sediment prior to pump installation. Furthermore, the pump should never be installed at the lowest point of the system due to the natural accumulation of dirt and sediment. If there is excessive sediment or suspended particles present, it is advised a strainer or filter be used.

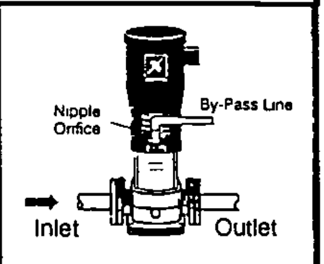
PLEASE NOTE:
THE CR(N) PUMPS ARE SHIPPED WITH PLUGGED SUCTION AND DISCHARGE. THE PLUGS MUST BE REMOVED BEFORE THE FINAL PIPE FLANGE TO PUMP CONNECTIONS ARE MADE.

Bypass

A bypass or pressure relief valve should be installed in the discharge pipe if there is any possibility the pump may operate against a closed valve in the discharge line. Flow through the pump is required to ensure adequate cooling and lubrication of the pump is maintained. See Table A on the next page for minimum flow rates.

Acceptable By-Pass Piping Arrangements



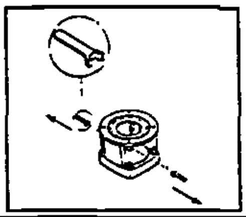


Installation Procedures

TABLE A. MINIMUM PUMPING RATES:

Pump Type	Min. Flow Rates
CR2/CRN2/CRN2G	1.2 GPM (0.25 M^3/HR)
CR4/CRN4/CRN4G	3.0 GPM (0.68 M^3/HR)
CR8/CRN8/CRN8G	5.3 GPM (1.20 M^3/HR)
CR16/CRN16/CRN16G	8.5 GPM (1.93 M^3/HR)
CR30/CRN30	13.5 GPM (3.07 M^3/HR)
CR60/CRN60	27.0 GPM (6.14 M^3/HR)

For Pump Ends Only (CR 2, 4, 8, 16)
Remove shaft seal protectors before installing motor (see diagram).



Electrical

WARNING
THE SAFE OPERATION OF THIS PUMP REQUIRES THAT IT BE GROUNDED IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND LOCAL GOVERNING CODES OR REGULATIONS. CONNECT THE GROUND WIRE TO THE GROUNDING SCREW IN THE TERMINAL BOX AND THEN TO THE ACCEPTABLE GROUNDING POINT.

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

Motor

Grundfos Series C Pumps are supplied with heavy-duty 3450 RPM, O.D.P., NEMA C frame motors selected to our rigid specifications. T.E.F.C. motors are also available. Motors for other voltages and frequencies are available on a special-order basis. If you are replacing the pumping unit, but using a motor previously used on another Series C pump, be sure to read the "Motor Replacement" section on page 10 for proper adjustment of the coupling height.

Motor Terminal Box Positions (Top View)

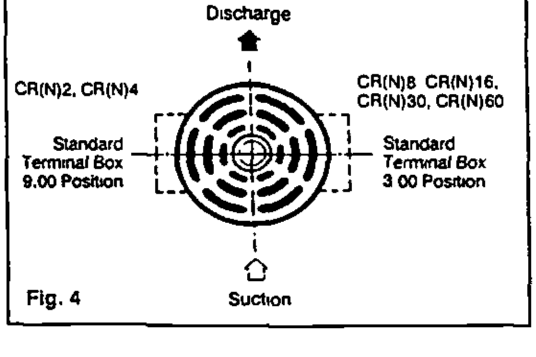


Fig. 4

Position of Terminal Box

The motor terminal box can be turned to any of four positions in 90° steps. To rotate the terminal box, remove the four bolts securing the motor to the pump; turn the motor to the desired location, replace and securely tighten the four bolts See Figure 4

685 332

Electrical

Field Wiring

Wire sizes should be based on the current carrying properties of a conductor as required by the latest edition of the National Electrical Code or local regulations. Direct on line (D.O.L.) starting is approved due to the extremely fast run-up time of the motor and the low moment of inertia of pump and motor. If D.O.L. starting is not acceptable and reduced starting current is required, an auto transformer or resistant starter should be used. It is suggested that a fused disconnect be used for each pump where service and standby pumps are installed.

Motor Protection

1. **Single-Phase Motors:**
   With the exception of 7 1/2 and 10 HP motors which require external protection, single-phase Series C pumps are equipped with multi-voltage, squirrel-cage induction motors with built-in thermal protection.

2. **Three-Phase Motors:**
   Series C Pumps with three-phase motors must be used with the proper size and type of motor-starter to ensure the motor is protected against damage from low voltage, phase failure, current imbalance and overloads. A properly sized starter with manual reset and ambient-compensated extra quick trip in all three legs should be used. The overload should be sized and adjusted to the full-load current rating of the motor. **Under no circumstances should the overloads be set to a higher value than the full load current shown on the motor nameplate. This will void the warranty.** Overloads for auto transformers and resistant starters should be sized in accordance with the recommendations of the manufacturer.

Operation and Maintenance

Starting the Pump the First Time

Priming

To prime the pump in a closed system or an open system where the water source is above the pump, close the pump isolation valve(s) and remove the priming plug from the pump head. See Figure 5A and 5B. Gradually open the isolation valve in the suction line until a steady stream of airless water runs out the priming port. Replace the plug and securely tighten. Completely open the isolation valves.

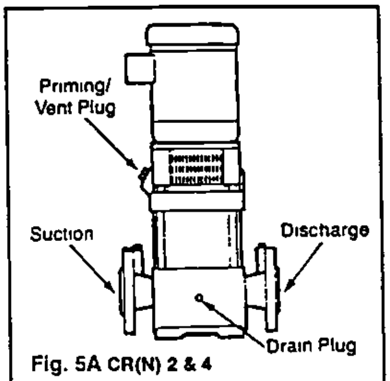


Fig. 5A CR(N) 2 & 4

In open systems where the water level is below the pump inlet, the suction pipe and pump must be filled and vented of air before starting the pump. Close the discharge isolation valve and remove the priming plug. Pour water through the priming hole until the suction pipe and pump are completely filled with water. If the suction pipe does not slope downward from the pump toward the water level, the air must be purged while being filled. Replace the priming plug and securely tighten.

Operation and Maintenance

Check the Direction of Rotation

1. Switch power off.
2. Check to make sure the pump has been filled and vented.
3. Remove the coupling guard and rotate the pump shaft to be certain it turns freely. Replace the coupling guard.
4. Verify that the electrical connections are in accordance with the wiring diagram on the motor.
5. Switch the power on and observe the direction of rotation. When viewed from the top, the pump should rotate counter-clockwise.
6. To reverse the direction of rotation, first switch OFF the supply power.
7. On three-phase motors, interchange any two power leads at the load side of the starter. On single-phase motors, see connection diagram on nameplate. Change wiring as required.
8. Switch on the power and again check for proper motor rotation.

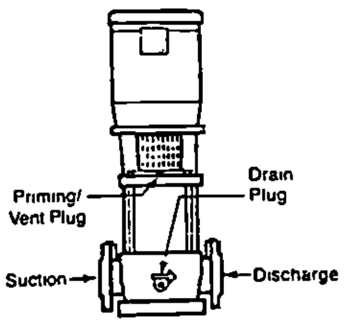
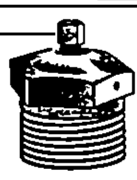


Fig. 5B CR(N)8, 16, 30 & 60

REMINDER

Do not start the pump before priming or venting the pump. Never operate the pump dry.



Starting and Adjusting

Before starting the pump, please check:

1. Pump is primed.
2. Direction of rotation is counter-clockwise when viewed from the top.
3. All piping connections are tight and the pipes are adequately supported.
4. Suction line isolation valve is completely opened, if a valve has been installed.
5. For initial starting, the isolation valve in the discharge pipe should be closed and gradually opened after the pump is turned on. Opening this valve too fast may result in some water hammering in the discharge pipe. Unless used as a flow throttling device, make sure this valve is completely open.
6. Check and record the voltage and amperage of the motor. Adjust the motor overloads if required.
7. Check and record operating pressures if pressure gauge have been installed.
8. Check all controls for proper operation. If pump is controlled by a pressure switch, check and adjust the cut-in and cut-out pressures If low-water-level controls are used, be sure the low level switch is properly adjusted so the pump cannot run if the pump should break suction.

Operating Parameters

Grundfos Series C multi-stage centrifugal pumps installed in accordance with these instructions and sized for correct performance will operate efficiently and provide

Operation and Maintenance

years of service. The pumps are water-lubricated and do not require any external lubrication or inspection. The motors will require periodic lubrication as noted in the following Maintenance Section.

Under no circumstances should the pump be operated for any prolonged periods of time without flow through the pump. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed to allow sufficient water to circulate through the pump to provide adequate cooling and lubricaton of the pump bearings and seals.

Pump cycling — Pump cycling should be checked to ensure the pump is not starting more than:

20 times per hour on 1/2 to 5 HP models,
15 times per hour on 7 1/2 to 15 HP models
10 times per hour on 20 to 30 HP models.

Rapid cycling is a major cause of premature motor failure due to increased heat build-up in the motor. If necessary, adjust controls to reduce the frequency of starts and stops.

Boiler-feed installations — If the pump is being used as a boiler-feed pump, make sure the pump is capable of supplying sufficient water throughout its entire evaporation and pressure ranges. Where modulating control valves are used, a bypass around the pump must be installed to ensure pump lubrication.

Maintenance

Freeze Protection:

If the pump is installed in an area where freezing could occur, the pump and system should be drained during freezing temperatures to avoid damage. To drain the pump, close the isolation valves, remove the priming plug and drain plug at the base of the pump. Do not replace the plugs until the pump is to be used again. Always replace the drain plug with the original or exact replacement. Do not replace with a standard plug. Internal recirculation will occur, reducing the output pressure and flow.

Motor Lubrication

Electric motors are pre-lubricated at the factory and do not require additional lubrication at start-up. Motors containing sealed bearings do not require additional lubrication during the first 15,000 hours of operation. Motors with grease fittings should only be lubricated with a lithium based grease. **Do not over grease the bearings.** Over greasing will cause increased bearing heat and can result in bearing/ motor failure.

Type of Service	Frequency of Greasing
Seasonal (motor is idle for more than 6 months)	Yearly
Intermittently	Semi-annually
Continuous	Quarterly

Approved Types of Grease	
Shell Dolium R	Texaco Regal
FSSO Beacon 3	Starfos Premium
BP-XRB2	*Recommend Mobilith SCH100 for 20 & 25 HP. It is required for 30 & 40 HP motors*
Shell Alvania 3	
Mobil Grease 2	

Procedure — If motor is equipped with Alemite fitting, clean tip of fitting and apply grease gun. Use 1 to 2 full strokes on motors in NEMA 215 frame and smaller. Use 2 to 3 strokes on NEMA 254 thru NEMA 365 frame. For initial greasing, be sure grease comes out grease relief on opposite side of motor from grease fitting. On motors having drain plugs, remove grease drain plug and operate motor for 20 minutes before replacing drain plug.

685 335

Operation and Maintenance

Regular Checkups

At regular intervals depending on the conditions and time of operation, the following checks should be made:

1. Pump meets required performance and is operating smoothly and quietly.
2. There are no leaks, particularly at the shaft seal.
3. The motor is not overheating.
4. Remove and clean all strainers or filters in the system.
5. Verify the tripping of the motor overload protection.
6. Check the operation of all controls. Check unit control cycling twice and adjust if necessary.
7. If the pump is not operated for unusually long periods, the unit should be maintained in accordance with these instructions. In addition, if the pump is not drained, the pump shaft should be manually rotated or run for short periods of time at monthly intervals.

If the pump fails to operate or there is a loss of performance, refer to the Trouble Shooting section on pages 12-15.

Motor Replacement

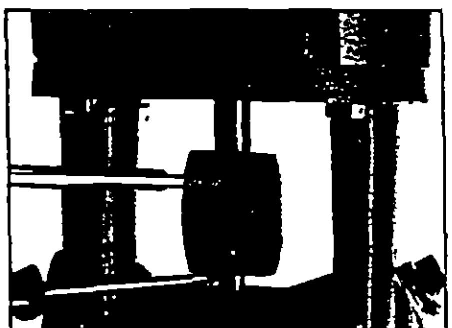
If the motor is damaged due to bearing failure, burning or electrical failure, the following instructions detail how to remove the motor for replacement. It must be emphasized that motors used on Series C pumps are specifically selected to our rigid specifications Replacement motors must be of the same NEMA C frame size, should be equipped with the same or better bearings and have the same service factor. Failure to follow these recommendations may result in premature motor failure.

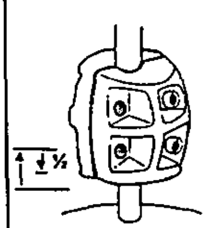
Disassembly

1. Remove the coupling guard screens.
2. Using the proper metric Allen wrench, loosen the four cap screws in the coupling.
3. With the correct size wrench, loosen and remove the four bolts which hold the motor to the pump end.
4. Lift the motor straight up until the shaft is free from the coupling.

Assembly

1. Thoroughly clean the surfaces of the motor and pump end mounting flanges. The motor and shaft must be clean of all oil/grease and other contaminants where the coupling attaches. Set the motor on the pump end.
2. Place the terminal box in the desired position by rotating the motor





- Note the clearance below the coupling
- Raise the coupling higher, as far as it will go
- Lower it halfway back down(1/2 the distance you just raised it)
- Tighten screws
  M6 10ft lbs (13Nm)
  M8 23ft lbs (31Nm)

685 336

Operation and Maintenance

3. Insert the mounting bolts, then diagonally and evenly tighten.
4. *Using a larger screwdriver, raise* the pump shaft by placing the tip of the screwdriver under the coupling and carefully elevating the coupling to its highest point. Note: The shaft can only be raised approximately 0.20 inches (5mm).
5. Now lower the shaft halfway back down the distance you just raised it (approximately the thickness of a dime), and retighten the metric cap screws in the coupling. Be sure to tighten the top and bottom screws on one side of the coupling and then the other. Torque coupling screws to the following specifications.

Coupling Bolt Size	Min. Torque Specifications
M6	10 ft-lbs.
M8	23 ft-lbs.
M10	46 ft-lbs.

6. Check to see that the gaps between the coupling halves are equal. Loosen and re-adjust if necessary.
7. Be certain the pump shaft can be rotated by hand. If the shaft cannot be rotated or it binds, disassemble and check for misalignment.
8. Replace the two coupling guard screens.

Parts Lists, Kits, and Accessories

Parts List

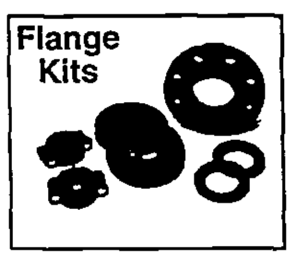
For each Series C pump model we offer an extensive **Parts List** and diagram of parts used in that pump and those we recommend you keep on hand for future maintenance. In addition, the listings also provide information about our prepackaged **Service Kits** of those pump components most likely to exhibit wear over time, as well as the complete **Impeller Stack** needed to replace the "guts" of each model. These **Parts Lists** are available separately from our literature warehouse or as a set with extensive service instructions in our **Series C Service Manuals** (for a small charge).

Spare Parts

For each model Grundfos sells, we offer an extensive list of spare parts for sale. For a current list of these parts, refer to our: *Plumbing & Heating/Industrial Service Kits, Tools, and Spare Parts Price List. Form # LSK-SL-002*

Prepackaged impeller stacks ready for immediate installation

Prepackaged Flange Kits

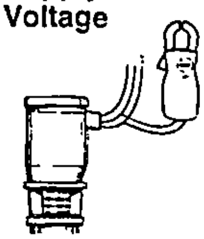


Troubleshooting

WARNING
WHEN WORKING WITH ELECTRICAL CIRCUITS, USE CAUTION TO AVOID ELECTRICAL SHOCK. IT IS RECOMMENDED THAT RUBBER GLOVES AND BOOTS BE WORN, AND METAL TERMINAL BOXES AND MOTORS ARE GROUNDED BEFORE ANY WORK IS DONE.
FOR YOUR PROTECTION, ALWAYS DISCONNECT THE PUMP FROM ITS POWER SOURCE BEFORE HANDLING.

Preliminary Tests

Supply Voltage



How to Measure

Use a volt meter, (set to the proper scale) measure the voltage at the pump terminal box or starter.

On single-phase units, measure between power leads L1 and L2 (or L1 and N for 115 volt units)
On three-phase units, measure between:
- Power leads L1 and L2
- Power leads L2 and L3
- Power leads L3 and L1

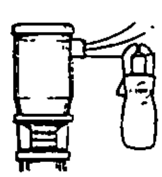
What It Means

When the motor is under load, the voltage should be within ±10% of the nameplate voltage. Larger voltage variation may cause winding damage

Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected.

If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.

Current Measurement



How to Measure

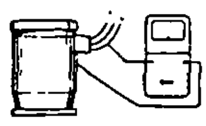
Use an ammeter, (set on the proper scale) to measure the current on each power lead at the terminal box or starter See the motor nameplate for amp draw information.

Current should be measured when the pump is operating at constant discharge pressure

What It Means

If the amp draw exceeds the listed service factor amps (SFA) or if the current imbalance is greater than 5% between each leg on three-phase units, check the following:
1. Burned contacts on motor starter.
2. Loose terminals in starter or terminal box or possible wire defect.
3. Too high or too low supply voltage
4. Motor windings are shorted or grounded. Check winding and insulation resistances.
5. Pump is damaged causing a motor overload

Insulation Resistance



How to Measure

Turn off power and disconnect the supply power leads in the pump terminal box Using an ohm or mega ohm meter, set the scale selector to Rx 100K and zero adjust the meter.

Measure and record the resistance between each of the terminals and ground

What It Means

Motors of all HP, voltage, phase and cycle duties have the same value of insulation resistance Resistance values for new motors must exceed 1,000,000 ohms If they do not, motor should be repaired or replaced.

Troubleshooting

Diagnosing Specific Problems

Problem	Possible Cause	Remedy
The pump does not run	1. No power at motor.	Check for voltage at motor teminal box. If no voltage at motor, check feeder panel for tripped circuits and reset circuit.
	2. Fuses are blown or circuit breakers are tripped.	Turn off power and remove fuses. Check for continuity with ohmmeter. Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation, motor and wires must be checked.
	3 Motor starter overloads are burned or have tripped out.	Check for voltage on line and load side of starter. Replace burned heaters or reset Inspect starter for other damage. If heater trips again, check the supply voltage and starter holding coil.
	4 Starter does not energize.	Energize control circuit and check for voltage at the holding coil. If no voltage, check control circuit fuses If voltage, check holding coil for shorts. Replace bad coil
	5. Defective controls	Check all safety and pressure switches for operation. Inspect contacts in control devices. Replace worn or defective parts or controls.
	6. Motor is defective.	Turn off power and disconnect wiring Measure the lead to lead resistances with ohmmeter (RX-1). Measure lead to ground values with ohmmeter (RX-100K). Record measured values. If an open or grounded winding is found, remove motor and repair or replace.
	7. Defective capacitor (Single-phase motors)	Turn off power and discharge capacitor. Check with ohmmeter (RX-100K). When the meter is connected to the capacitor, the needle should jump towards 0 ohms and slowly drift back to infinity (∞). Replace if defective.
	8. Pump is bound.	Turn off power and manually rotate pump shaft. If shaft does not rotate easily, check coupling setting and adjust as necessary If shaft rotation is still tight, remove pump and inspect Disassemble and repair
The pump runs but at reduced capacity or does not deliver water	1. Wrong rotation	Check wiring for proper connections Correct wiring.
	2. Pump is not primed or is airbound.	Turn pump off, close isolation valve(s), remove priming plug. Check fluid level. Refill the pump, replace plug and start the pump Long suction lines must be filled before starting the pump
	3. Strainers, check or foot valves are clogged	Remove strainer, screen or valve and inspect Clean and replace. Reprime pump

Troubleshooting

Problem	*Possible Cause*	*Remedy*
The pump runs but at reduced capacity or does not deliver water	4. Suction lift too large.	Install compound pressure gauge at the suction side of the pump. Start pump and compare reading to performance data. Reduce suction lift by lowering pump increase suction line size or removing high friction loss devices.
	5. Suction and/or discharge piping leaks.	Pump runs backwards when turned off. Air in suction pipe. Suction pipe, valves and fittings must be airtight. Repair any leaks and retighten all loose fittings.
	6. Pump worn.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shutoff. Convert measured pressure (in PSI) to head (in feet)· (Measured PSI x 2 31 ft./PSI = ____ ft.) Refer to the specific pump curve for shutoff head for that pump model If head is close to curve, pump is probably OK. If not, remove pump and inspect.
	7 Pump impeller or guide vane is clogged.	Disassemble and inspect pump passageways Remove any foreign materials found.
	8. Incorrect drain plug installed	If the proper drain plug is replaced with a standard plug, water will recirculate internally Replace with proper plug
Pump cycles too much	1. Pressure switch is not properly adjusted or is defective	Check pressure setting on switch and operation. Check voltage across closed contacts. Readjust switch or replace if defective.
	2 Level control is not properly set or is defective.	Check setting and operation Readjust setting (refer to level control manufacturer's data) Replace if defective.
	3 Insufficient air charging or leaking tank or piping.	Pump air into tank or diaphragm chamber Check diaphragm for leak Check tank and piping for leaks with soap and water solution Check air to water volume Repair as necessary.
	4 Tank is too small.	Check tank size and air volume in tank Tank volume should be approximately 10 gallons for each gpm of pump capacity. The normal air volume is 2/3 of the total tank volume at the pump cut-in pressure Replace tank with one of correct size
	5 Pump is oversized	Install pressure gauges on or near pump suction and discharge ports Start and run pump under normal conditions, record gauge readings Convert PSI to feet (Measured PSI x 2.31 ft /PSI = ______ ft) Refer to the specific pump curve for that model, ensure that total head is sufficient to limit pump delivery within its design flow range Throttle pump discharge flow if necessary

685 349

Troubleshooting

Problem	Possible Cause	Remedy
Fuses blow or circuit breakers or overload relays trip	1. Low voltage.	Check voltage at starter panel and motor. If voltage varies more than ±10%, contact power company. Check wire sizing.
	2. Motor overloads are set too low.	Cycle pump and measure amperage. Increase heater size or adjust trip setting to a maximum of motor nameplate (full load) current.
	3. Three-phase current is imbalanced.	Check current draw on each lead to the motor. Must be within ±5%. If not, check motor and wiring. Rotating all leads may eliminate this problem.
	4 Motor is shorted or grounded	Turn off power and disconnect wiring. Measure the lead-to-lead resistance with an ohmmeter (RX-1). Measure lead-to-ground values with an ohmmeter (RX-100K) or a megaohm meter Record values If an open or grounded winding is found, remove the motor, repair and/or replace
	5 Wiring or connections are faulty.	Check proper wiring and loose terminals Tighten loose terminals Replace damaged wire.
	6 Pump is bound.	Turn off power and manually rotate pump shaft. If shaft does not rotate easily, check coupling setting and adjust as necessary. If shaft rotation is still tight, remove pump and inspect. Disassemble and repair.
	7. Defective capacitor (single-phase motors).	Turn off power and discharge capacitor. Check with ohmmeter (RX-100K). When the meter is connected to the capacitor, the needle should jump towards 0 ohms and slowly drift back to infinity (∞). Replace if defective.
	8. Motor overloads at higher ambient temperature than motor.	Use a thermometer to check the ambient temperature near the overloads and motor Record these values. If ambient temperature at motor is lower than at overloads, especially where temperature at overloads is above 104°F (40°C), ambient-compensated heaters should replace standard heaters.

685 341

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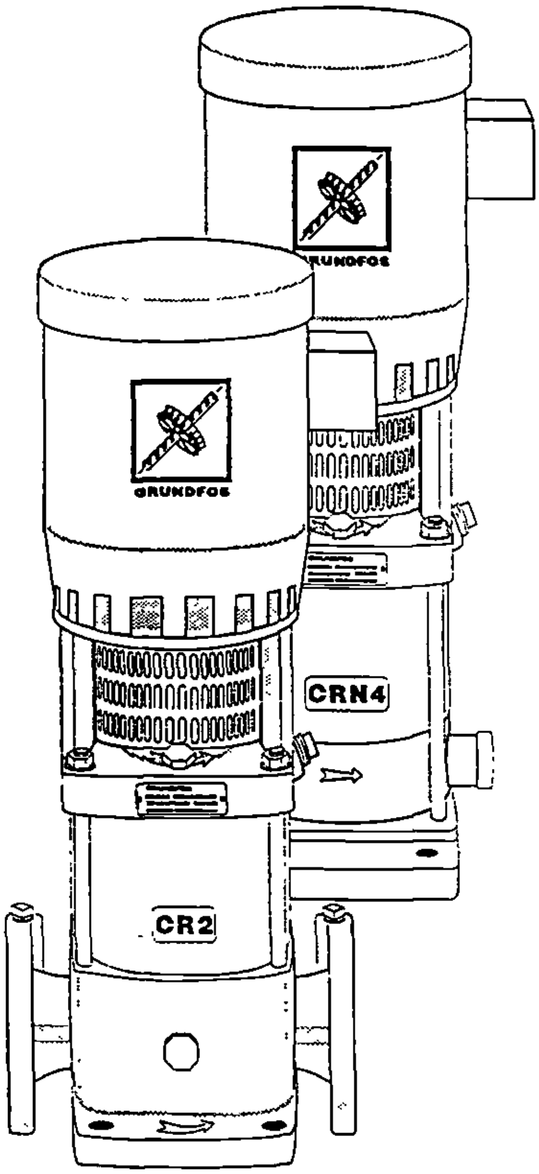

Impeller Stack Kit Dismantling and Reassembly

CR2 · CR4

Series C

(We recommend installing a Shaft Seal & Gasket kit along with this kit.)

685 342

DISMANTLING

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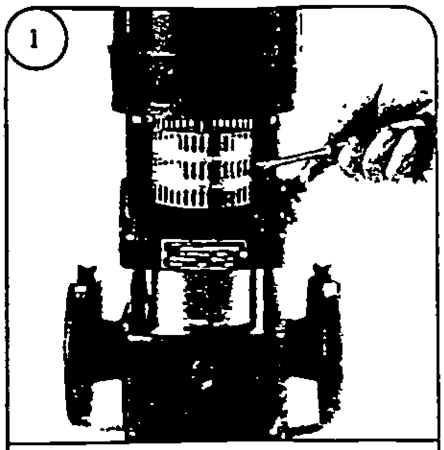
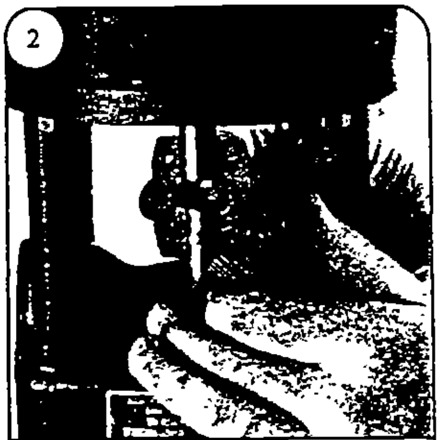
1



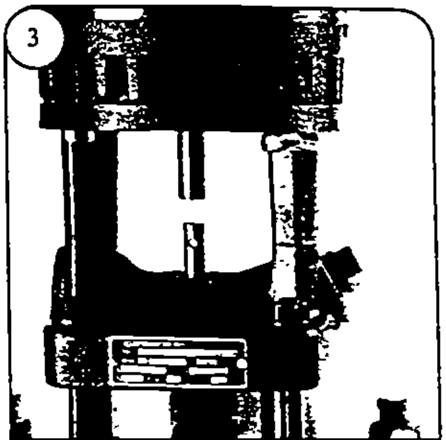
Using a screwdriver, hook into the two coupling guards and remove them.

2



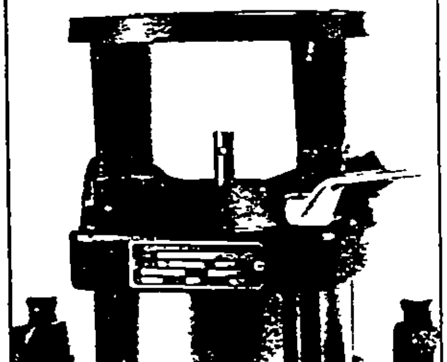
Using an allen wrench, remove the allen screws in the coupling and remove the two coupling halves Remove the shaft pin from the shaft.

3



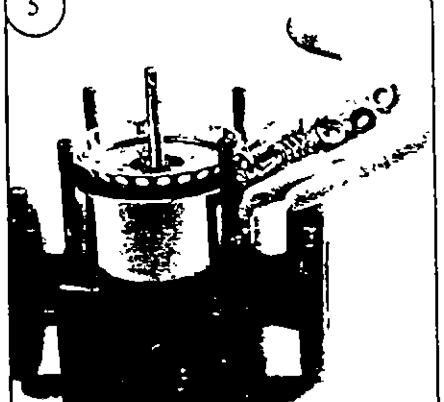
Using a wrench, remove the motor bolts holding the pump and motor together. Lift the motor off the pump.

4



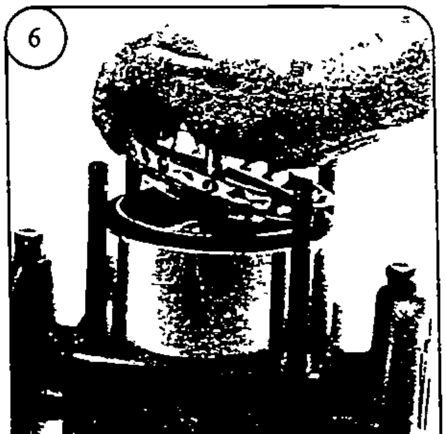
Loosen the staybolt nuts diagonally and remove them and the washers. Use a light, upward blow with a rubber hammer to loosen the pump head

5



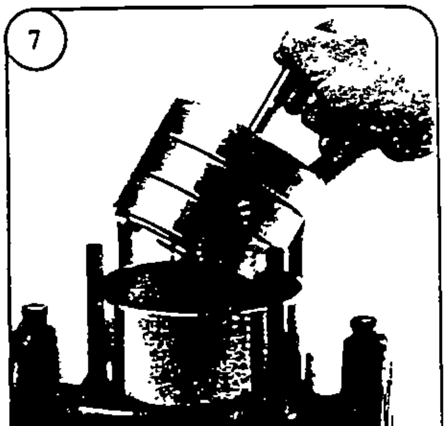
Remove the lower seal ring (104), upper seal driver (111) with O-ring (107), seal spring (108), and the lower seal driver (112) from the shaft.

6



Pry up and remove the top guide vane or (on CR4 only) the top plate . If it does not lift off easily, a light blow with a rubber hammer may first be needed to jolt it loose from the impeller stack

7

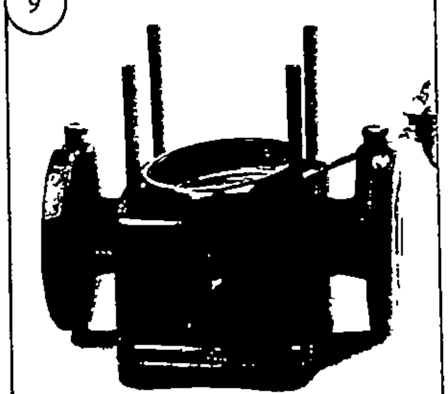


Grab the shaft and lift the impeller stack off the pump If it is stuck, a light blow with a rubber hammer may be needed to jolt the stack free The bottom intermediate chamber may remain in the suction/discharge chamber

8

Lift the outer sleeve off the pump and remove the gasket from the base

9



If it has not already been removed, use a screwdriver to pry the bottom intermediate chamber off the suction/discharge chamber and remove the O-ring

685 343

LIMITED WARRANTY

Products manufactured by (GRUNDFOS) GRUNDFOS PUMPS CORPORATION are warranted to the original user only to be free of defects in material and workmanship for a period of 18 months from date of installation, but not more than 24 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS' manufacture GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS' products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

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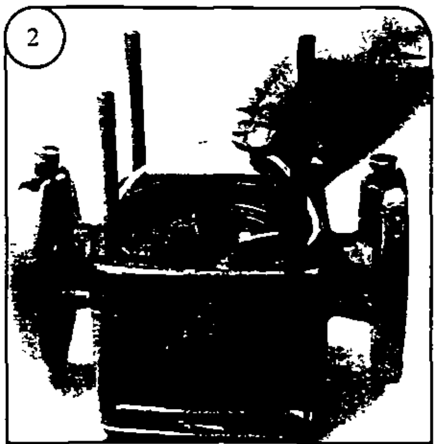
1

Lubricate the O-ring with warm, soapy water and carefully push it over the collar of the circulation hole in the bottom intermediate chamber.

2



Position the outer sleeve gasket in the recess of the suction/discharge chamber.

6

REFER TO THE DIAGRAM AND COMPLETE THESE STEPS:

O-RING TYPE

(a) Fit the lower seal driver (112) onto the shaft, making sure the bottom "teeth" engage with those of the shaft seal spacer (61). Fit the seal spring (108), and upper seal driver (111) onto the shaft.

(b) Moisten the O-ring (107) with warm, soapy water, fit it onto the shaft and press it down against the upper seal driver (111). Make sure it is not damaged as it passes over the shaft pin hole.

(c) Press the upper seal driver down against the spring, making sure the drivers engage properly.

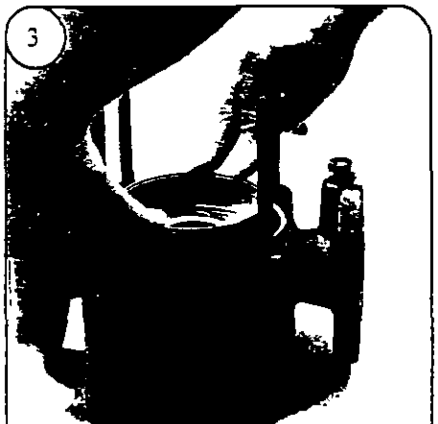
(d) Fit the lower seal ring (104) - **shiny side up** - over the upper seal driver (111) so the taps of the seal ring engage with the driver.
If the pump will not be put back into service immediately, the shiny side (top) of the Lower Seal Ring (pos 104) should be lubricated with a very small amount of silicon oil to prevent the seal from sticking during storage.

BELLOWS TYPE SHAFT SEAL

(a) Moisten the rubber bellows (105) with warm soapy water. Slide the seal onto the shaft, until it comes in contact with the shaft seal spacer already on the shaft.

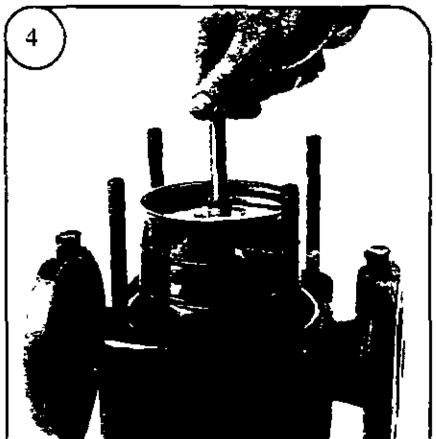
(b) Fit the secondary seal (105a) around the stationary seal face. Moisten with warm soapy water and push the seal---in the motor stool. Make sure the shiny side is pointing down to mate up against the rotating bellows.

3



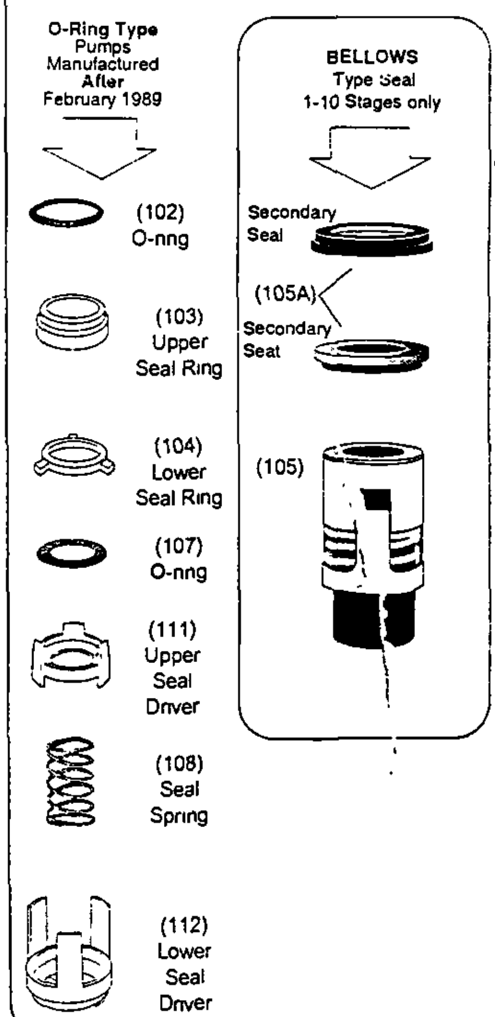
Taking care not to disturb the O-ring, fit the bottom intermediate chamber in the suction/discharge chamber. Press it down so the circulation hole of the intermediate chamber is exactly above the circulation hole of the suction/discharge chamber.

4



Remove the impeller stack from the box, and fit it onto the bottom intermediate chamber.

THE MECHANICAL SEAL ASSEMBLY



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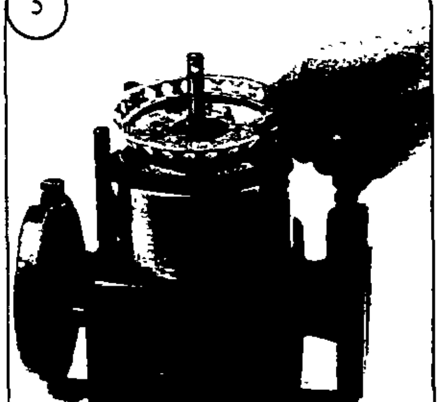
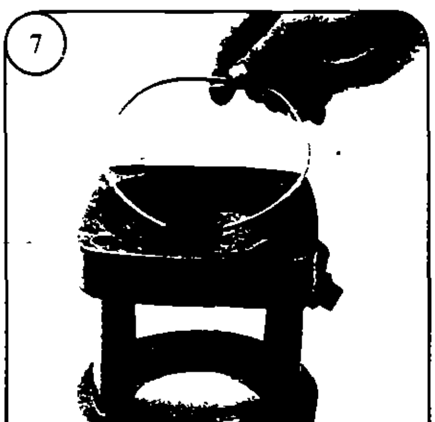


Fit the outer sleeve over the impeller stack and press the top guide vane or top plate (50b for CR4 only) into place on the top intermediate chamber

7

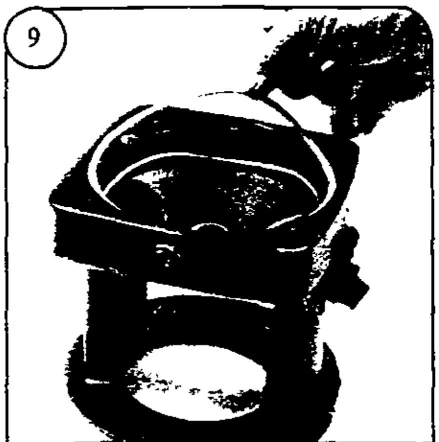


Clean the recessed areas in the motor stool that will hold the seal ring and outer sleeve gasket. Lubricate them with an FDA-approved lubricant. With the ends pointing down, fit the corrugated spring into its recessed area.

8

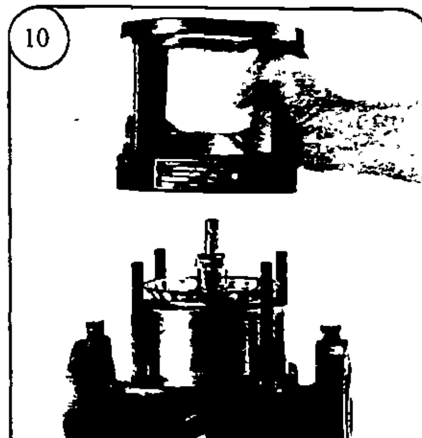
Moisten the O-ring (102) with soapy water, fit it onto the upper seal ring (103), and fit both snugly into the recess area in the motor stool (O-ring end first). *NEVER* strike the seal face with *any* hard object. Gently wipe the seal face clean (no *solvents !*).

9



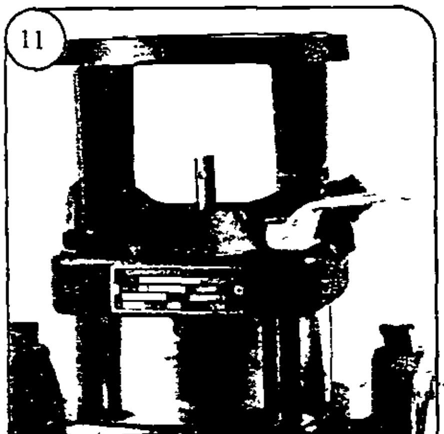
Fit the outer sleeve gasket (37) into its recessed area in the motor stool. Press the shaft seal assembly (on the shaft) down a few times to make sure the drivers are still engaged

10



Fit the motor stool over the staybolts. Make sure the priming plug points in the direction you wish. As you lower the motor stool, make sure the outer sleeve gasket does not catch onto the guide vanes.

11

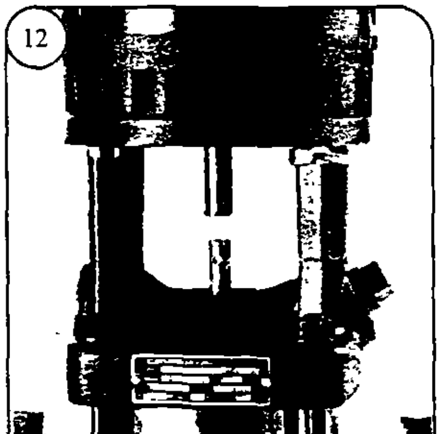


Replace the staybolt washers and nuts (sprayed first with food machinery oil) and tighten diagonally to 30 ft lbs (40 Nm)

① ③
④ ②

Diagonal tightening (overhead view)

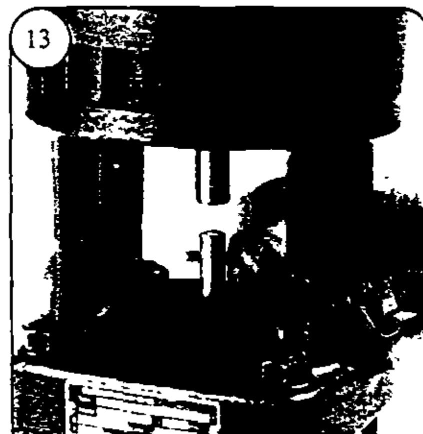
12



Fit the motor onto the motor stool Replace the screws and tighten diagonally to 10 ft lbs (13 Nm) for UNC 3/8" bolts and to 23 ft lbs (31 Nm) for UNC 1/2" bolts

Diagonal tightening (overhead view)

13



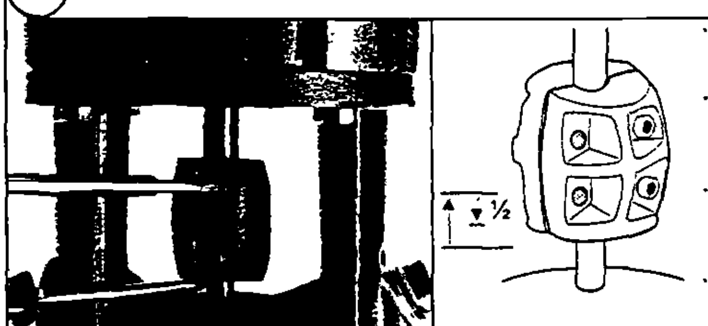
Fit the shaft pin in the shaft hole.

14

Fit the two coupling halves and hand tighten the allen screws into the coupling. Check to make sure the gaps on either side of the *coupling are even Spray the* allen screws with food machinery oil

15

SETTING THE COUPLING HEIGHT



- **Note the clearance below the coupling**
- **Raise the coupling higher, as far a s it will go**
- **Lower it halfway back down (½ the distance you just raised it)**
- **Tighten screws M6...10 ft lbs (13 Nm) M8...23 ft lbs (31 Nm)**

With a screwdriver in one hand and allen wrench in the other, raise the coupling (with the screwdriver) as high as it will go (at least 2 mm higher) Make sure the shaft is moving up and down with the coupling (there will be a little bit of "play" before the shaft moves). Lower the coupling halfway back down the distance you just raised it. Tighten *the allen screws two and two (one side at a time) Check to make sure the gaps on either side are even* Check your work by turning the coupling(it should rotate freely) If the shaft is very tight or won't rotate at all, you have a problem (missing spacer, wrong parts, etc)

16

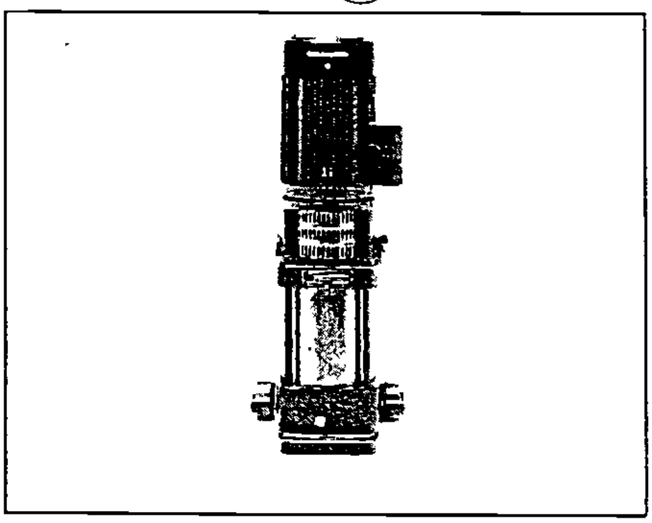
Spring the two coupling guards back into place THE PUMP IS NOW COMPLETELY ASSEMBLED.

685 346

Service Kits

CR(N) 2
CR(N) 4

- (GB) Shaft Seal
- (D) Wellenabdichtung
- (F) Garniture mécanique
- (I) Tenuta meccanica
- (E) Cierre mecánico
- (P) Empanque
- (NL) Asafdichting
- (S) Axeltätning
- (SF) Akselitiiviste
- (DK) Akseltætning
- (SA) مانع تسرب العامود
- (GR) Στεγανοποιηση άξονα



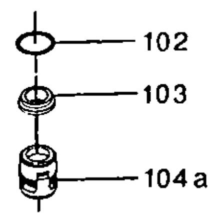
99 02 58 94 09

GRUNDFOS

685 347

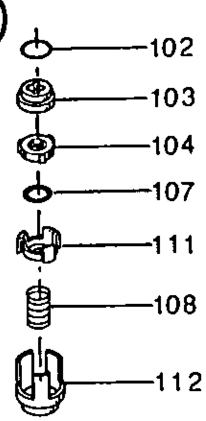
CR 2 CRN 2 CR 4 CRN 4	C D	BUBE BUBV	1
	A B C D	A AUUE AUUV	2

1



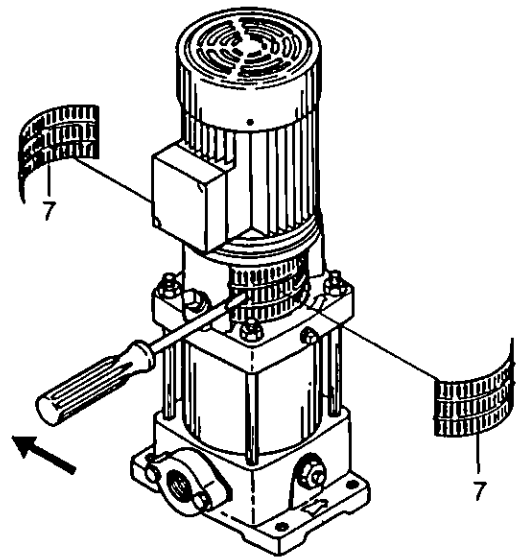
 max. 16 bar

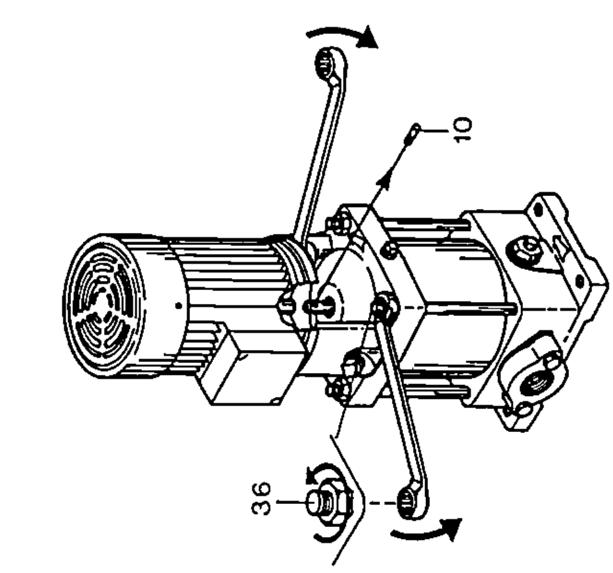
2



max. 25 bar

(GB) Dismantling
(D) Demontage
(F) Démontage
(I) Smontaggio
(E) Desmontaje
(P) Desmontagem
(NL) Demonteren
(S) Demontering
(SF) Purkaminen
(DK) Demontering
(SA) تفكيـــــك
(GR) Αποσυναρμολόγηση





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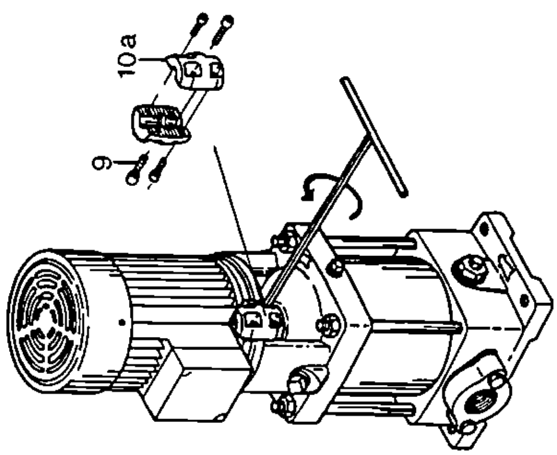

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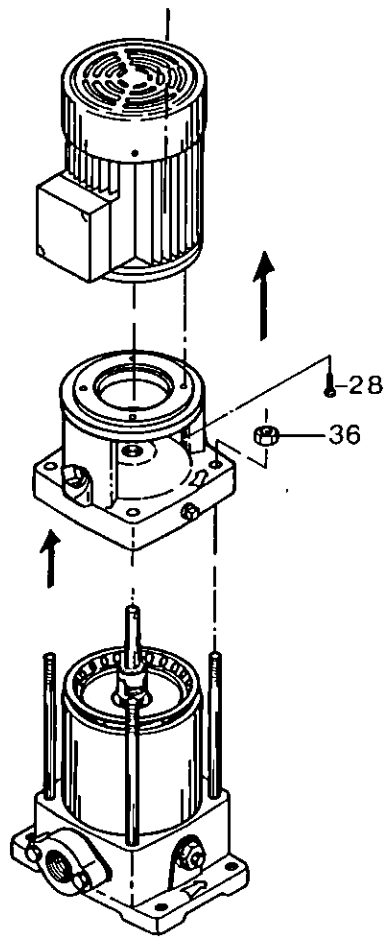

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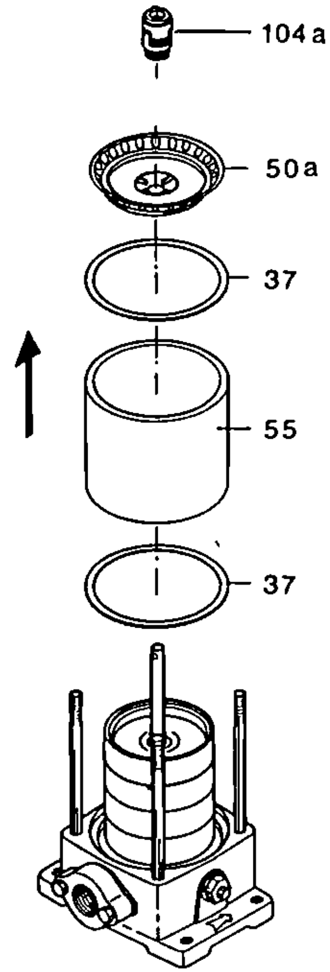

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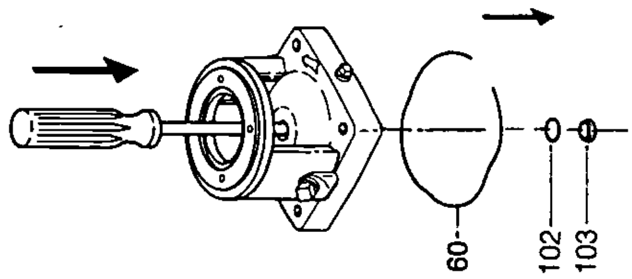
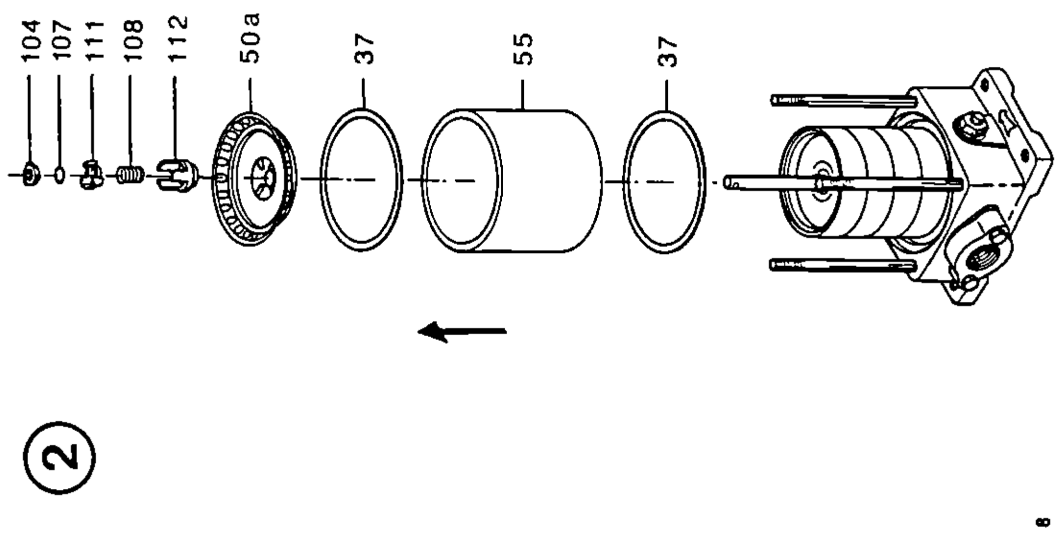
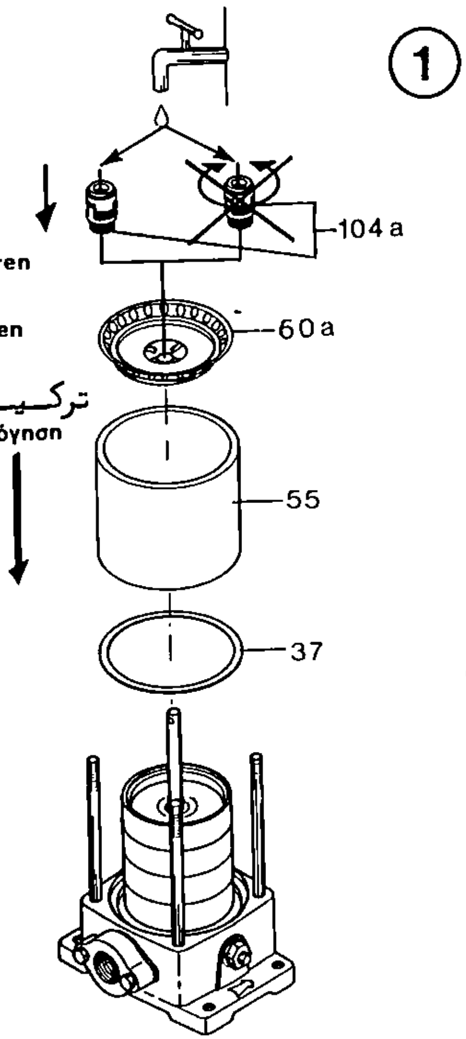
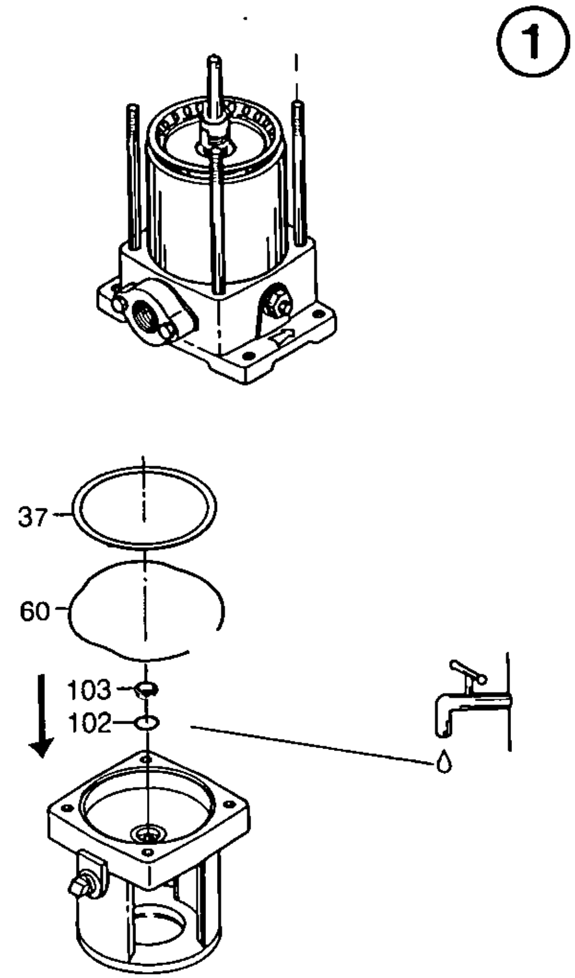


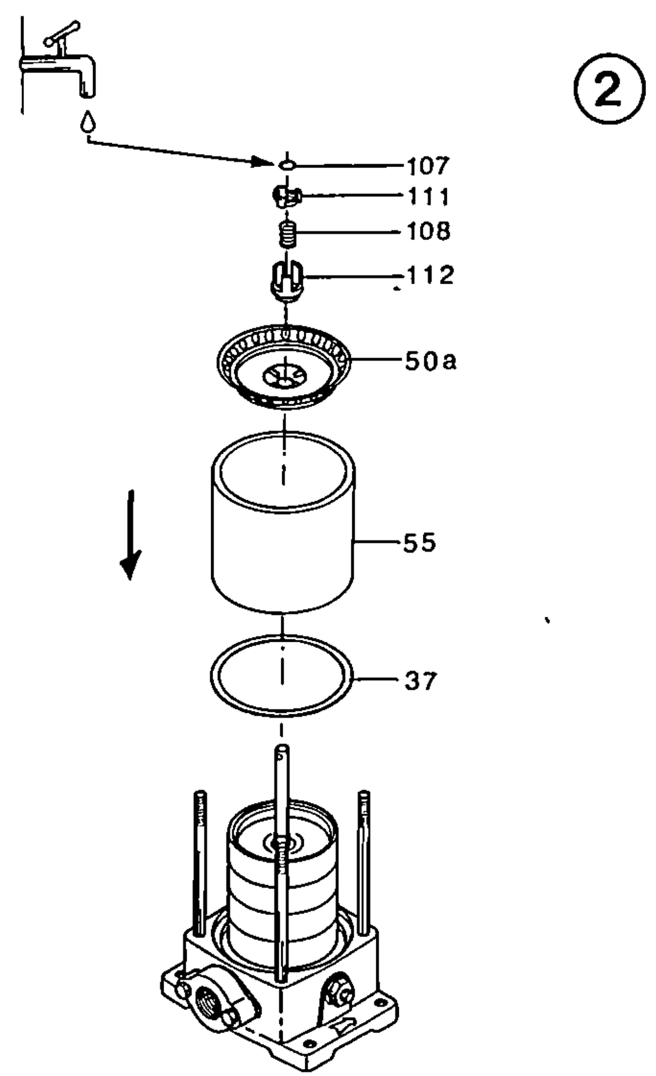


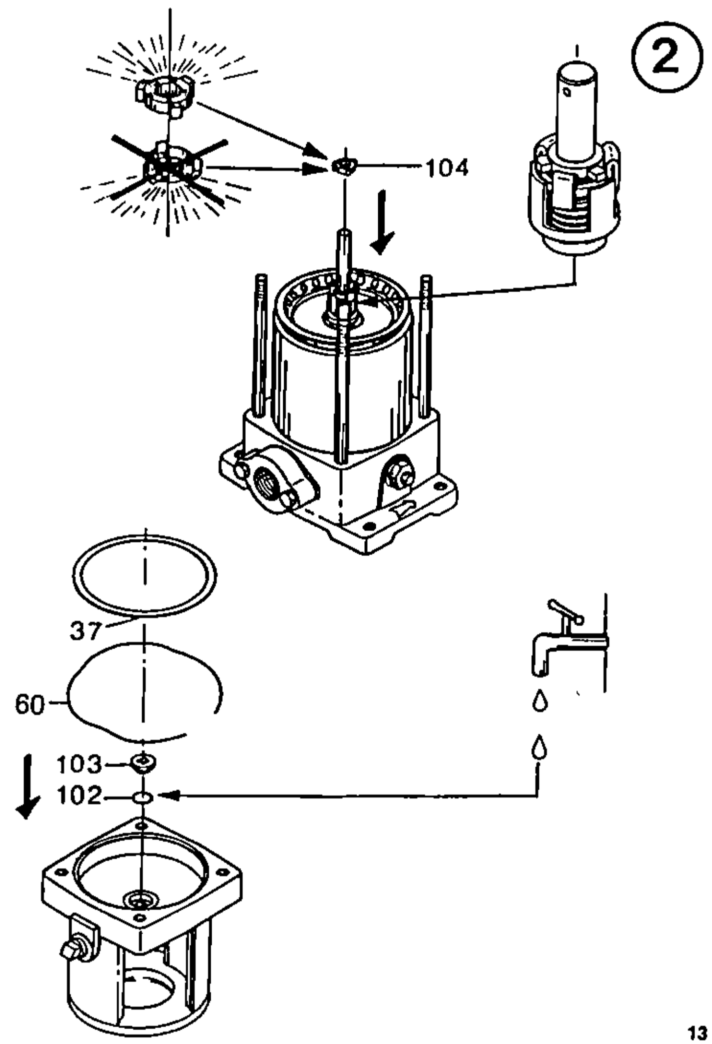
685 351

(GB) Assembly
(D) Montage
(F) Montage
(I) Montaggio
(E) Montaje
(P) Montagem
(NL) Assembleren
(S) Montering
(SF) Kokoaminen
(DK) Montering
(SA) تركيب
(GR) Συναρμολόγηση









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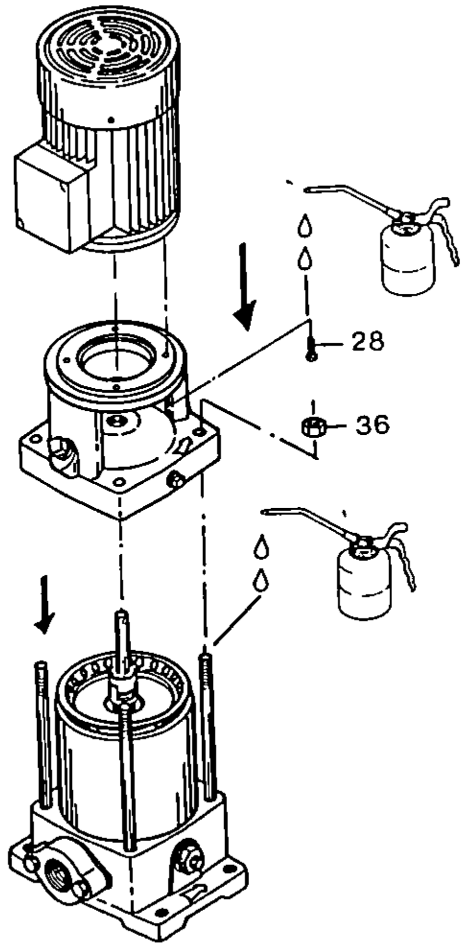

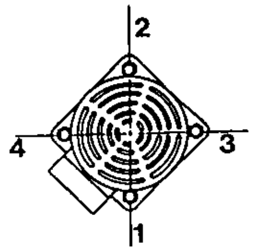

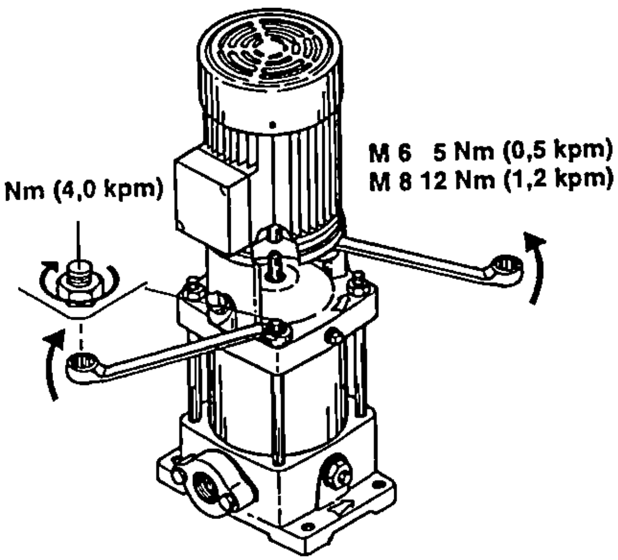

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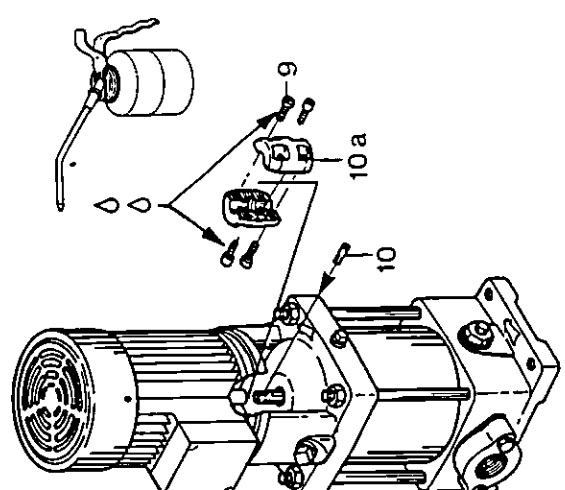

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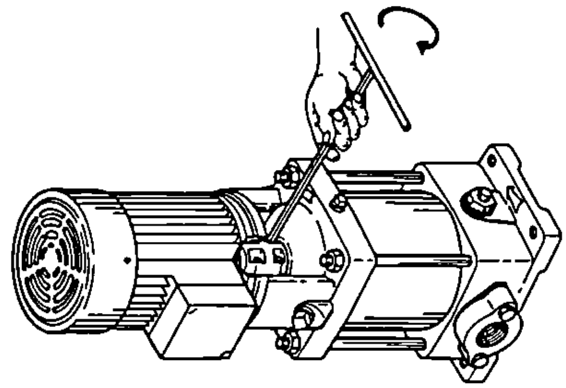

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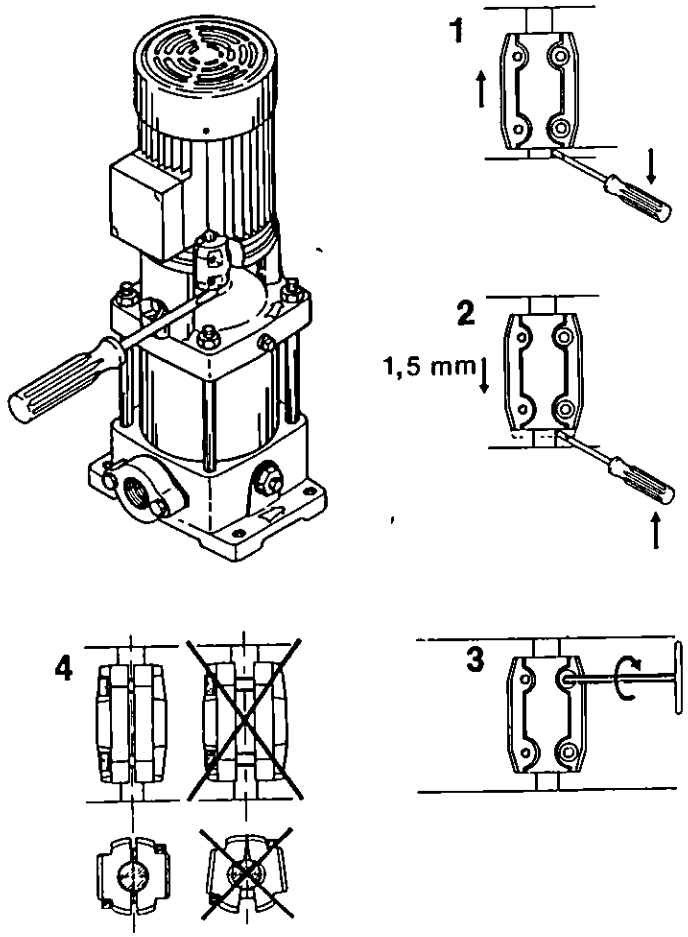
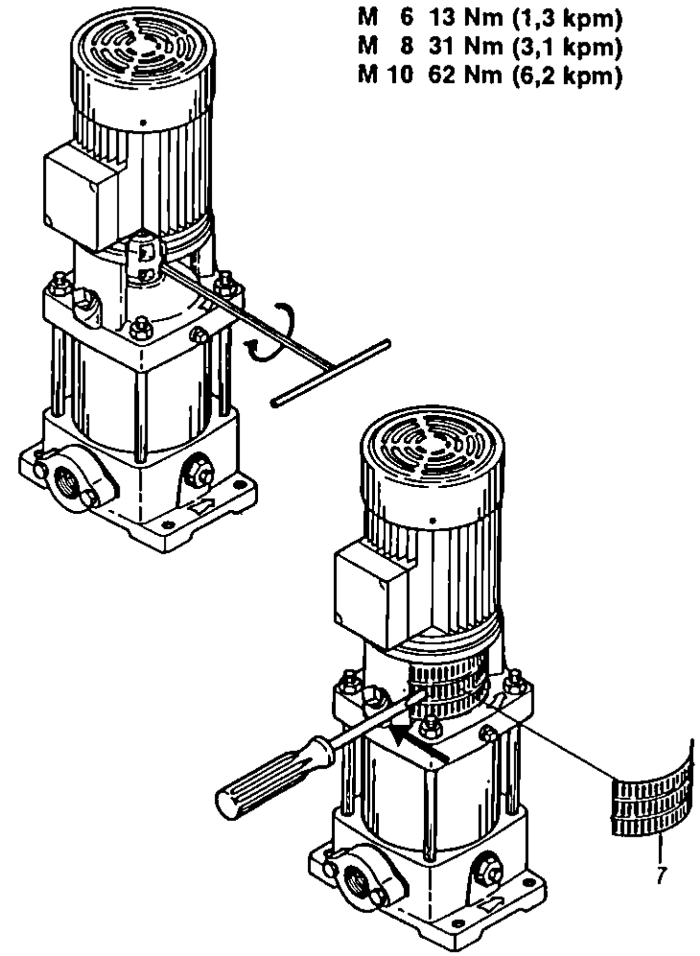
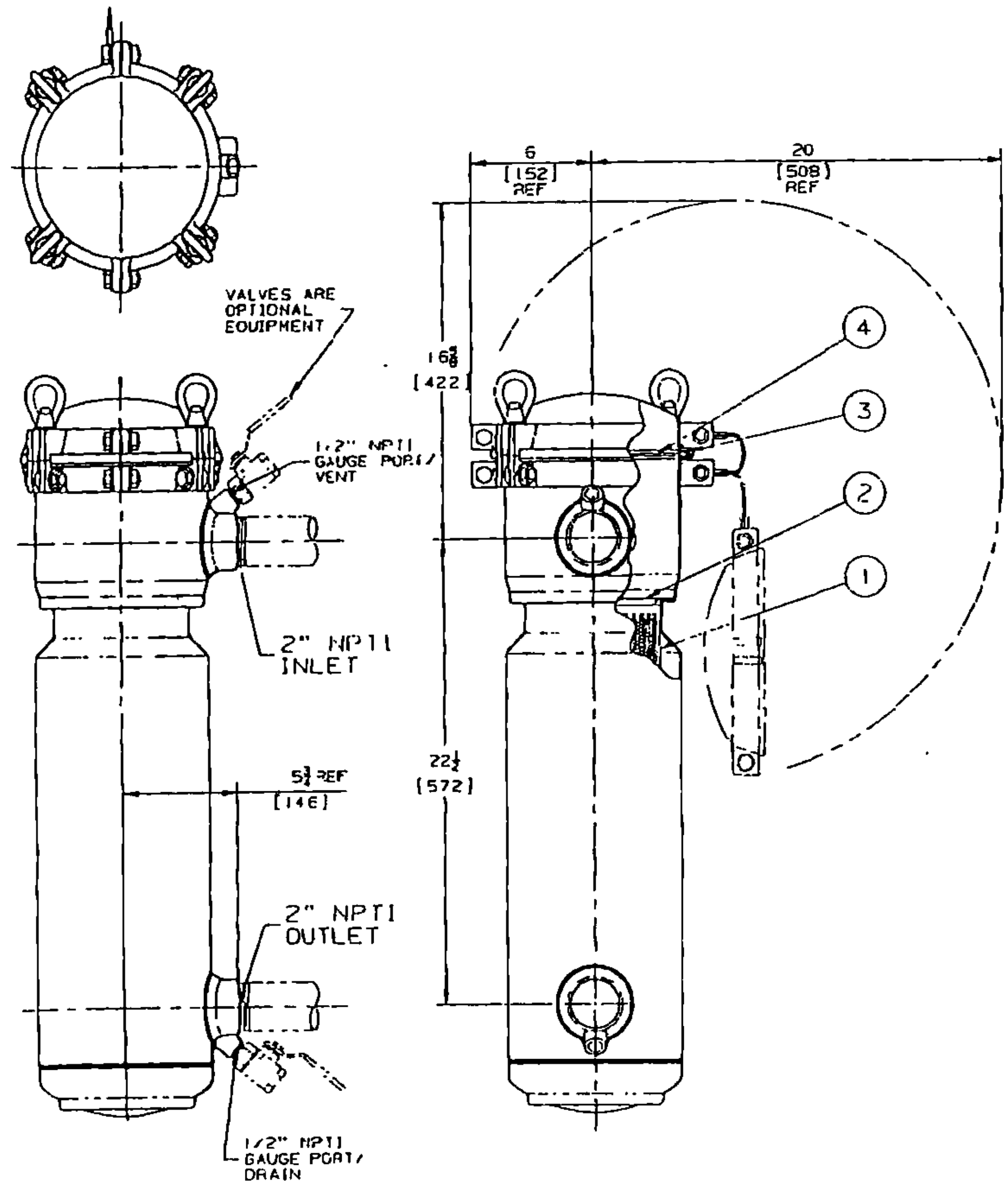


M 6 13 Nm (1,3 kpm)
M 8 31 Nm (3,1 kpm)
M 10 62 Nm (6,2 kpm)





NOTES.

1. ALL DIMENSIONS ARE IN INCHES WITH MILLIMETER EQUIVALENTS IN PARENTHESES [ ].
2. DESIGN CONDITIONS:
   PRESSURE: 100 PSIG [6.9 BAR]
   TEMPERATURE: 220° F [104.4 °C] MAX
   -20° F [-28.9 °C] MIN
   HYDROSTATIC TEST: 150 PSIG [10.3 BAR]
3. CLEARANCE REQUIRED FROM INLET CENTERLINE FOR BASKET REMOVAL: 27" [696].

*** SPECIFY ELASTOMER MATERIAL:
BUN = BUNA-N EPT = NORDEL
VIT = VITON FGL = FOOD GRADE
SIL = SILICONE TFV = TEFLON

** SPECIFY MATERIAL:
CST = CARBON STEEL
SS4 = 304 STAINLESS STEEL

* OPTIONAL

6	2	P-43849-**	*REDUCER BUSHING 2" TO 1"
5	2	P-43848-**	*REDUCER BUSHING 2" TO 1-1/2"
4	1	P-43835-SS6	RING, ENVELOPE SEAL
3	1	BP-10082-***	ENVELOPE SEAL
2	1		FABRIC FILTER BASKET
1	1		*BASKET, WIRE MESH INLAY
			*BASKET, STRAINER
		P-43841-SS4	BAG RETAINER, PERF TUBE
NO	REQ'D	PART NUMBER	DESCRIPTION

SCALE 1/4"=1"	R-P PRODUCTS
DATE 2/27/96	A DIVISION OF RONNINGEN-PETTER
DRAWN X IESS	FABRI-BASKET LP
APPROVED	304 STAINLESS STEEL & CARBON STEEL
TOLERANCES:	

REV	DESCRIPTION OF CHANGE	BY	DATE

685 357

Now you can have the quality, performance, convenience, serviceability and versatility of an industrial bag filter at a price lower than a cartridge filter's The key is using spun metal technology to fabricate the filter housing Spun metal technology allows fewer parts, lower assembly labor, and lower material requirements for lower total manufacturing and shipping costs

With only two major parts (the housing and filter bag), the LP series bag filter has fewer joints than other low-cost bag filters That means eliminating pockets and crevices where contamination can accumulate, making cleaning much easier

Operating limits

Maximum line pressure 100 psi* (7 kg/cm²)*
Maximum differential pressure 100 psid (7 kg/cm²)
Maximum temperatures (continuous operation)

Media

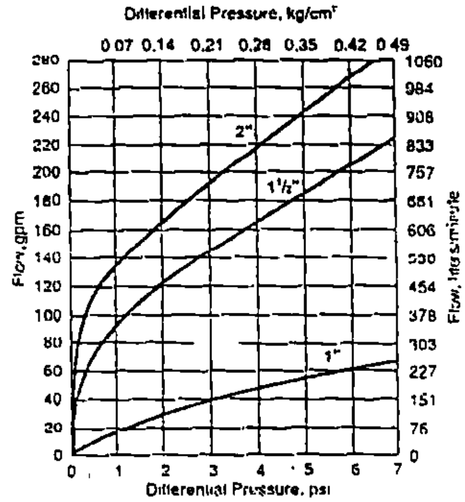
Polypropylene	180°F (82°C)
Bonded Polyester	220°F (104°C)
Nylon	275°F (135°C)
Polyester	300°F (149°C)
316SS Wire Mesh Inlay and Perforated Strainer Basket	450°F (232°C)

Elastomers (seals/gaskets)

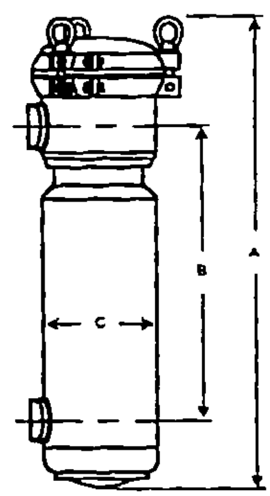
Buna N	220°F (104°C)
White Neoprene	225°F (107°C)
Nordel** (EPT)	300°F (149°C)
High-Temperature Viton**	400°F (204°C)
Silicone	450°F (232°C)

*If operating pressures can exceed this limit a pressure-relieving device must be installed
**Trademark of E I DuPont de Nemours and Company
• Optional equipment Wall mount hardware, four legged floor stand

Flow vs. differential pressure



These curves are based on flow of clear water at a minimum inlet pressure of 25 psi (1 75 kg/cm²) Differential pressure will increase correspondingly with increased solids loading For more viscous liquids or at retentions of 10 micron or finer, differential pressure will be higher



Inlet/ Outlet Diameter	Dimensions			Shipping Weight (Approximate)		Surface Area Total
	A	B	C	304 Stainless	Carbon Steel	
1" (25 mm)	36" REF (918 mm)	22½" (572 mm)	8⅝" O D (220 mm)	50 lb (22.7 kg)	55 lb (24.9 kg)	510 sq in (3 290 cm²)
1½" (38 mm)	36" REF (918 mm)	22½" (572 mm)	8⅝" O D. (220 mm)	50 lb (22.7 kg)	55 lb (24 9 kg)	510 sq in (3,290 cm²)
2" (50 mm)	36" REF (918 mm)	22½" (572 mm)	8⅝" O.D (220 mm)	50 lb (22.7 kg)	55 lb (24 9 kg)	510 sq. in. (3,290 cm²)

Flotec®

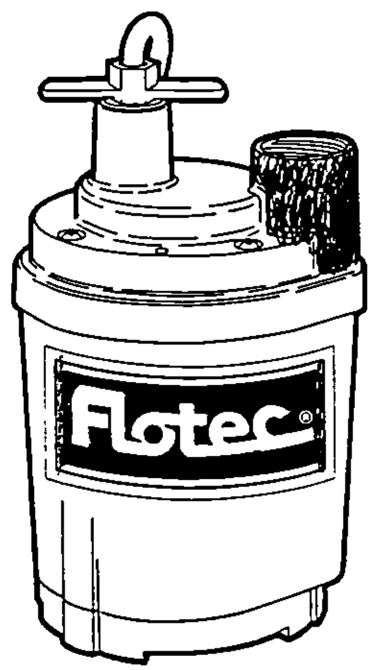
Sta-Rite Industries / a WICOR company
P.O. Box 342, Delavan, WI 53115

685 358

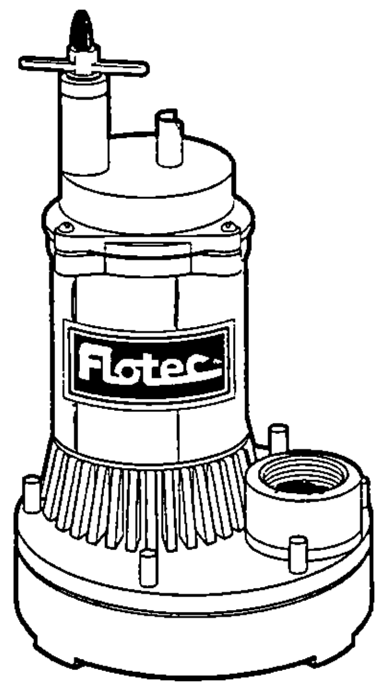
OWNER'S MANUAL
Submersible Utility Pumps
Series FP0S1300X, FP0S1600X, FP0S1250X

NOTICE D'UTILISATION
Pompes utilité submersibles
Série FP0S1300X, FP0S1600X, FP0S1250X

MANUAL DEL USUARIO
Bombas sumergibles de uso general
Serie FP0S1300X, FP0S1600X, FP0S1250X



Series FP0S1300X/FP0S1600X



Series FP0S1250X

Installation/Operation/Parts

For further operating, installation, or maintenance assistance:

Call 1-800-365-6832

Installation/Fonctionnement/Pièces

Pour plus de renseignements concernant l'utilisation, l'installation ou l'entretien,

Composer le 1 (800) 365-6832

Instalación/Operación/Piezas

Para mayor información sobre el funcionamiento, instalación o mantenimiento de la bomba:

Llame al 1-800-365-6832

PRINTED IN U S A

FP288 (Rev 9/27/96)

685-359

ENGLISH

DESCRIPTION

The submersible pump is designed for water removal in home applications Pump can be used for sump service and dewatering Unit is constructed of hi-impact corrosion resistant plastic. Screened inlet prevents large solids from entering pump.

SPECIFICATIONS

Power supply required		115V, 60 HZ
Motor duty		Continuous*
Liquid Temp Range		Max. 77°F (25°C)
Operation Position		Vertical
Circuit Requirement		15 Amp
Operating Depth	Beginning min	1/2"
(water level)	Ending max	3/16"
Discharge		1" NPT (25 mm)

* For model FP0S1250X, maintain minimum water level of 4" (127mm) for continuous use to prevent overheating

PERFORMANCE

GPH (LPH) AT TOTAL FEET (M)						
3'(0 91)	5'(1.52)	10'(3 05)	15'(4.57)	18'(5 49)	20'(6 09)	22'(6 70)
FP0S1250X						
1140 gal	1050 gal	840 gal	480 gal	0 gal	-	-
(4 315 L)	(3 975 L)	(3 180 L)	(1 817 L)	(0 L)	-	-
FP0S1300X						
1320 gal	1250 gal	930 gal	660 gal	630 gal	0 gal	-
(4 996 L)	(4 731 L)	(3 520 L)	(2 498 L)	(2 385 L)	(0 L)	-
FP0S1600X						
1600 gal	1524 gal	1260 gal	924 gal	648 gal	372 gal	0 gal
(6 056 L)	(5 768 L)	(4 769 L)	(3 497 L)	(2 452 L)	(1 408)	(0 L)

NOTICE: This unit is not designed for applications involving salt water or brine! Prevent unit from freezing!

GENERAL SAFETY INFORMATION

Electrically powered sump pumps normally give many years of trouble-free service when correctly installed, maintained, and used However, unusual circumstances (interruption of power to the pump, dirt/debris in the sump, flooding that exceeds the pump's capacity, electrical or mechanical failure in the pump, etc.) may prevent your pump from functioning normally. To prevent possible water damage due to flooding, consult your retailer about a secondary AC sump pump, a DC backup sump pump, and/or a high water alarm. See the "Troubleshooting Chart" in this manual for information about common sump pump problems and remedies. For more information, see your retailer or call Flotec customer service at 1-800-365-6832.

1. Know the pump application, limitations, and potential hazards.

   ⚠WARNING Do not use in explosive atmospheres. Pump water only with this pump. Failure to follow this warning can result in personal injury and/or property damage.

   ⚠CAUTION Risk of flooding. If a flexible discharge hose is used, make sure pump is secured in sump to prevent movement. Failure to secure pump may allow pump movement, switch interference and prevent pump from starting or stopping.
2. Make certain power source conforms to requirements of your equipment.
3. Disconnect power before servicing
4. Release all pressure within system before servicing any component
5. Drain all water from system before servicing
6. Secure discharge line before starting pump An unsecured discharge line will whip, possibly causing personal injury and/or property damage
7. Check hoses for weak or worn condition before each use, making certain all connections are secure
8. Periodically inspect pump and system components Keep sump, pump and system free of debris and foreign objects Perform routine maintenance as required
9. Provide means of pressure relief on pumps whose discharge line can be shut-off or obstructed
10. Personal Safety
    a Wear safety glasses at all times when working with pumps
    b Keep work area clean, uncluttered and properly lighted – replace all unused tools and equipment
    c Keep visitors at a safe distance from the work area
    d Make workshop child-proof – with padlocks, master switches, and by removing starter keys.
11. When wiring an electrically driven pump, follow all electrical and safety codes, as well as most recent National Electrical Code (NEC) and Occupational Safety and Health Act (OSHA).

    ⚠WARNING Pump motor is equipped with an automatic resetting thermal protector and may restart unexpectedly.
12. **⚠WARNING Risk of electric shock.** This equipment is only for use on 115 volt (single phase) and is equipped with an approved 3-conductor cord and 3-prong, grounding-type plug

    ⚠WARNING To reduce risk of electric shock, be certain that it is connected to properly grounded, grounding-type receptacle.

    Where a 2-prong wall receptacle is encountered, it must be replaced with properly grounded 3-prong receptacle installed in accordance with the National Electrical Code and local codes and ordinances.
13. All wiring should be performed by a qualified electrician.
14. Protect electrical cord from sharp objects, hot surfaces, oil, and chemicals Avoid kinking cord. Replace or repair damaged or worn cords immediately
15. Use wire of adequate size to minimize voltage drop at motor. Refer to most recent National Electrical Code.
16. Do not touch an operating motor. Modern motors are designed to operate at high temperatures

INSTALLATION

⚠WARNING Do not use power cord to lift motor. Always use handle.

1. Pump should be located and should rest on level solid foundation Do not suspend pump by means of discharge pipe or power cord. Keep pump inlet screen clear.
2. Thread outlet pipe into pump body carefully to avoid stripping or crossing threads.
   a To install with garden hose, install adapter provided with pump
   NOTICE: To keep friction as low as possible, hose must be 3/4" or larger Keep hose as short as possible
   b To install with rigid pipe, use plastic pipe Wrap thread with Teflon tape or use Plasto Joint Stik*. Screw pipe into pump hand tight +1 - 1-1/2 turns.
3. Power Supply. Pump is designed for 115V., 60 HZ operation and requires a circuit of 15 amperes or more capacity It is supplied with a 3-wire cord set with grounding-type plug for use in a 3-wire, grounded outlet 3 wire extension cord, of at least 14 AWG ($2mm^2$) size is suggested, with larger sizes for runs over 25 ft (7M) For safety, pump should always be electrically grounded to a suitable electrical ground such as a grounded water pipe or a properly grounded metallic raceway, or ground wire system Do not cut off the round grounding prong.

   ⚠WARNING The pump motor is equipped with automatic resetting thermal protector and may restart unexpectedly. Protector tripping is indication of motor overloading as a result of operating pump at low heads (low discharge restriction), excessively high or low voltage, inadequate wiring, incorrect motor connections, or a defective motor or pump.

OPERATION

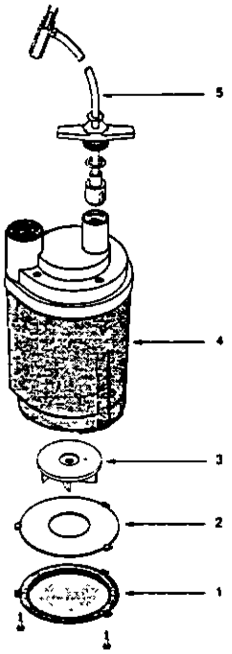
⚠WARNING Risk of electric shock. Do not handle pump or pump motor with wet hands or when standing on wet or damp surface, or in water.

1. Shaft seal depends on water for lubrication Do not operate pump unless it is in at least 1/2" (12.7mm) of water as seal may be damaged if allowed to run dry
2. Motor is equipped with automatic reset thermal protector. If temperature in motor should rise unduly, switch will cut off all power before damage can be done to motor When motor has cooled sufficiently, switch will reset automatically and restart motor If protector trips repeatedly, pump should be removed and checked as to cause of difficulty Low voltage, long extension cords, clogged impeller, very low head or lift, etc., could cause cycling

* Lake Chemical Co , Chicago, Illinois

3. Pump will pump water down to 3/16" (4.75mm), this means that it will not remove all water If unit has been operating and suddenly no water comes out of discharge hose, shut off unit immediately Water level is probably very low and unit has broken prime Use mop or squeegee to remove remaining water.
4. For Model FP0S1250X, do not run pump continuously for more than 15 minutes with water level below 4"(101 6mm) If motor overload trips and stops pump, allow unit to cool for one hour before restarting. Motor will not restart before overload has cooled.

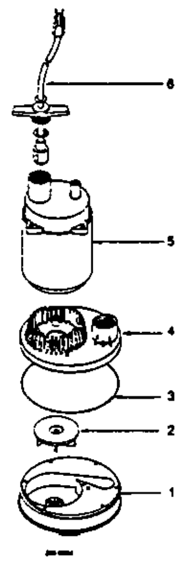
⚠WARNING **Risk of electric shock. Before attempting to check why unit has stopped operating, disconnect power from unit. Do not handle pump with wet hands or when standing on wet or damp surfaces, or in water. Failure to follow precaution can result in personal injury and/or property damage.**



REPAIR PARTS
MODELS FP0S1300X-03, FP0S1600X

KEY NO.	PART NO.	DESCRIPTION	QTY.
1	PS8-5P	Screen	1
2	PS70-3P	Shield	1
3	PS5-24P	Impeller - S1300X	1
3	PS5-25P	Impeller - S1600X	1
4	**	Motor	1
5	PS17-54	Power cord	1
•	FT0013-43	Garden Hose Adapter	1

**If motor fails, replace entire pump •Not Illustrated



REPAIR PARTS
MODELS FP0S1250X-01, FP0S1250X-02

KEY NO.	PART NO.	DESCRIPTION	QTY.
1	FP0005797A	Lower base plate	1
2	PS5-24P	Impeller	1
3	U9-406	Volute Gasket	1
4	FP0005796A	Upper base plate	1
5	**	Motor	1
6	PS17-54	Power cord	1
•	FT0013-43	Garden Hose Adapter	1

**If motor fails, replace entire pump •Not Illustrated

TROUBLE-SHOOTING CHART

SYMPTOM	PROBABLE CAUSE(S)	CORRECTIVE ACTION
Pump won't start or run.	Blown fuse.	If blown, replace with fuse of proper size.
	Low line voltage.	If voltage under recommended minimum, check size of wiring from main switch on property. If OK, contact power company.
	Defective motor.	Replace pump.
	Impeller.	If impeller won't turn, for model FP0S1250X, remove housing; for model FP0S1300X, remove screen Locate source of binding.
Pump operates but delivers little or no water	Low line voltage.	Use only 14 gauge or larger extension cords. Use short extension cords when necessary.
	Something caught in impeller.	Clean out impeller.
	Small diameter garden hose or long discharge line.	Use larger diameter garden hose or 1" flexible pipe Eliminate any excess hose. Short hoses work best.
	Check valve installed without vent hole.	Drill a 1/16" - 1/8" (1.6 - 3 2 mm) dia. hole between pump discharge & check valve.

685 361

FLOTEC LIMITED WARRANTY

FLOTEC warrants to the original consumer purchaser ("Purchaser") of its products that they are free from defects in material or workmanship

If within twelve (12) months from the date of the original consumer purchase any such product shall prove to be defective it shall be repaired or replaced at FLOTEC's option, subject to the terms and conditions set forth below Your dated proof of purchase will be used to determine warranty eligibility

Exceptions to the Twelve (12) Month Warranty

Ninety (90) Day Warranty:

If within ninety (90) days from original consumer purchase any Drill Pump or In-Line Water Filter Cartridge shall prove to be defective, it shall be replaced, subject to the terms set forth below.

Three (3) Year Warranty:

If within three (3) years from original consumer purchase any 4" Submersible Well Pump shall prove to be defective, it shall be repaired or replaced at FLOTEC's option, subject to the terms set forth below

Five (5) Year Warranty:

If within five (5) years from original consumer purchase any Pre-Charge water system tank shall prove to be defective, it shall be repaired or replaced at FLOTEC's option, subject to the terms and conditions set forth below

General Terms and Conditions

Purchaser must pay all labor and shipping charges necessary to replace product covered by this warranty This warranty shall not apply to acts of God, nor shall it apply to products which, in the sole judgement of FLOTEC, have been subject to negligence, abuse, accident, misapplication, tampering, alteration, nor due to improper installation operation, maintenance or storage, nor to other than normal application, use of service, including but not limited to, operational failures caused by corrosion, rust or other foreign materials in the system, or operation at pressures in excess of recommended maximums.

Requests for service under this warranty shall be made by returning the defective product to the Retail outlet or to FLOTEC as soon as possible after the discovery of any alleged defect FLOTEC will subsequently take corrective action as promptly as reasonably possible No requests for service under this warranty will be accepted if received more than 30 days after the term of the warranty

This warranty sets forth FLOTEC's sole obligation and purchaser's exclusive remedy for defective products

FLOTEC SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, OR CONTINGENT DAMAGES WHATSOEVER.

THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS WARRANTIES, IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, SHALL NOT EXTEND BEYOND THE DURATION OF THE APPLICABLE EXPRESS WARRANTIES PROVIDED HEREIN.

Some states do not allow the exclusion or limitation of incidental or consequential damages or limitations on how long an implied warranty lasts, so the above limitations or exclusions may not apply to you This warranty gives you specific legal rights and you may also have other rights which vary from state to state

FLOTEC / P O Box 342 / Delavan, WI U.S.A. 53115

GARANTIE LIMITÉE FLOTEC

FLOTEC garantit à l'acheteur-utilisateur initial de ses produits ("Acheteur") contre tout défaut de fabrication et de matériaux

Tout produit reconnu défectueux dans les douze (12) mois qui suivent la date d'achat d'origine sera remplace ou reparé à la discrétion de FLOTEC, selon les conditions stipulees ci-dessous La preuve datée de l'achat servira à déterminer si le produit est sous garantie

Exceptions à la garantie de douze (12) mois

Garantie de quatre-vingt dix (90) jours ·

Si, dans les quatre-vingt-dix (90) jours à compter de la date de son achat par l acheteur initial toute mini-pompe entraînee par perceuse ou cartouche de filtre à eau en ligne s avère défectueuse, elle sera remplacée sous réserve des conditions énoncées ci-dessous

Garantie de trois (3) ans ·

Si, dans les trois (3) ans qui suivent la date d achat par l acheteur au détail d'origine, une pompe de puits submersible de 4 pouces se révèle être défectueuse elle sera réparée ou remplacée, au choix de FLOTEC, conformément aux modalités et conditions stipulées ci-dessous

Garantie de cinq (5) ans :

Si dans les cinq (5) ans à compter de la date de son achat par l acheteur initial, tout réservoir de système d'eau préchargé s avère défectueux, FLOTEC s engage à son choix, de la réparer ou de le remplacer, sous réserve des termes et conditions énoncés ci-dessous

Conditions générales

L Acheteur s'engage à payer tous les frais de main-d'œuvre et d'expédition nécessaires au remplacement du produit couvert par la garantie Cette garantie ne couvrira pas les cas de force majeure, et ne s'appliquera pas aux produits qui, du seul avis de FLOTEC, ont fait l'objet de négligence, d'utilisation abusive ou incorrecte, d'accident, de modification ou d altération , ni aux produits qui n'ont pas été installés, utilisés, entreposés ou entretenus correctement , ni à ceux qui n'ont pas été utilisés ou entretenus normalement, y compris, mais sans s'y limiter, aux produits ayant des pannes de fonctionnement causées par la corrosion, la rouille ou autre corps étranger dans le système, ou à des produits ayant fonctionné à des pressions dépassant la limite maximale recommandée

Les demandes de service en vertu de la présente garantie seront faites en retournant le produit défectueux au détaillant ou à FLOTEC dès la découverte de tout défaut allégué FLOTEC prendra alors les mesures correctives aussi rapidement qu il est raisonnablement possible Aucune demande de service en vertu de la presente garantie ne sera acceptée si elle est reçue plus de 30 jours après l'expiration de la dite garantie

La présente garantie énonce la totalité des obligations de FLOTEC et le seul recours possible de l'Acheteur dans le cas de produits défectueux.

FLOTEC NE SERA TENU RESPONSABLE D'AUCUN DOMMAGE INDIRECT, ACCIDENTEL OU FORTUIT QUEL QU'IL SOIT.

LES PRESENTES GARANTIES SONT EXCLUSIVES ET TIENNENT LIEU DE TOUTE AUTRE GARANTIE EXPRESSE LES GARANTIES IMPLICITES, Y COMPRIS, MAIS SANS S'Y LIMITER LES GARANTIES IMPLICITES AYANT TRAIT A LA COMMERCIABILITE ET À L'ADAPTATION A UN USAGE PARTICULIER, NE DEPASSERONT PAS LA DUREE DES GARANTIES EXPRESSES APPLICABLES STIPULEES DANS LES PRESENTES

Certaines provinces n'autorisent pas d'exclure ou de limiter les dommages fortuits ou indirects ou de limiter la durée d'une garantie implicite , il se peut donc que les limitations ou exclusions ci-dessus ne s'appliquent pas à votre cas La presente garantie vous donne des droits juridiques specifiques et vous pouvez en avoir d'autres qui varient d'une province à l'autre

FLOTEC/P.O. Box 342/Delavan, WI U.S.A. 53115

GARANTÍA LIMITADA DE FLOTEC

FLOTEC garantiza al comprador consumidor original ("Comprador") de sus productos, que éstos se encuentran libres de defectos de material o mano de obra.

Si dentro de los doce (12) meses de la fecha original de la compra cualquiera de los productos demostrara estar defectuoso, el mismo será reparado o reemplazado, a opción de FLOTEC con sujeción a los términos y condiciones expuestos a continuación. Se utilizará la prueba de compra fechada para determinar la aplicación de la garantía.

Excepciones a la Garantía por Doce (12) Meses

Garantía por Noventa (90) Días

Si dentro de los noventa (90) días de efectuada la compra por parte del cliente original, cualquier bomba perforadora o cartucho de filtro de agua en la tubería demostrase tener defectos, éste o ésta será reemplazado/a segun los términos indicados más adelante

Garantía por Tres (3) Años

Si dentro de los tres (3) años de efectuada la compra por parte del cliente original, cualquier bomba d e pozo sumergible de 4" demostrase tener defectos, ésta será reparada o reemplazada a opción de FLOTEC segun los términos y condiciones indicados más adelante

Garantía por Cinco (5) Años

Si dentro de los cinco (5) años de efectuada la compra por parte del cliente original, cualquier tanque pre-carga del sistema de agua demostrase tener defectos, éste será reparado o reemplazado a opción de FLOTEC, segun los términos y condiciones indicados más adelante

Términos y Condiciones Generales

El comprador debe pagar todos los gastos de mano de obra y transporte necesarios para reemplazar el producto cubierto por esta garantía. Esta garantía no se aplicará a hechos de fuerza mayor, ni se aplicará a los productos que, a juicio exclusivo de FLOTEC, hayan sido objeto de negligencia, abuso, accidente, aplicaciones contraindicadas, manejo indebido, alteraciones, ni debido a instalación, funcionamiento, mantenimiento o almacenaje incorrectos, ni a ninguna otra cosa que no sea su aplicación, uso o servicio normales, incluyendo, pero no limitado a, fallas operacionales causadas por corrosión, oxidación u otros elementos extraños en el sistema, o funcionamiento a presión por encima del máximo recomendado

Los pedidos de servicio bajo los términos de esta garantía serán efectuados mediante la devolución del producto defectuoso al Vendedor o a FLOTEC, tan pronto como sea posible, después de localizado cualquier supuesto defecto FLOTEC tomará luego acción correctiva, tan pronto como sea razonablemente posible Ningun pedido de servicio bajo esta garantía será aceptado si se recibe más de 30 días después del término de la garantía.

Esta garantía establece la obligación unica de FLOTEC y el remedio exclusivo del comprador en el caso de productos defectuosos

FLOTEC NO SERA RESPONSABLE POR NINGÚN DAÑO CONSECUENTE, INCIDENTAL O CONTINGENTE DE NINGUNA NATURALEZA.

LAS GARANTIAS ANTERIORES SON EXCLUSIVAS Y REEMPLAZAN CUALESQUIERA OTRAS GARANTÍAS EXPRESAS LAS GARANTÍASIMPLÍCITAS, INCLUYENDO, PERO NO LIMITADAS A, LAS GARANTIAS IMPLÍCITAS DE COMERCIABILIDAD Y APTITUD PARA UN PROPOSITO EN PARTICULAR, NO DEBERAN EXCEDER EL PERIODO DE DURACIÓN DE LAS GARANTIAS EXPRESAS APLICABLES AQUI PROVISTAS

Algunos estados no permiten la exclusión o limitación de daños incidentales o consecuentes ni las limitaciones respecto a la duración de garantías implícitas, de modo que las limitaciones o exclusiones precedentes pueden no aplicarse en su caso Esta garantía le concede derechos legales específicos Usted puede tener, además, otros derechos que varian de un estado a otro

FLOTEC/ P O. Box 342 / Delavan, WI U.S A. 53115

685 362

Verbatim™

OWNER'S MANUAL

VBS

BASIC MODEL

RACO®

REMOTE ALARMS AND CONTROLS

RACO MANUFACTURING & ENGINEERING, CO.
400 62nd Street, Emeryville, CA 94608 (510) 658-6713
1-800-722-6999 FAX # 1-510-658-3153

RACO

REMOTE ALARMS AND CONTROLS

685 363

RACO Manufacturing and Engineering Co., 1400 62nd St., Emeryville, CA 94608 (510) 658-6713 800-722-6999 FAX (510) 658-3153

DIALER SPECIFICATION - VERBATIM® BASIC

July 15, 1992

Description & Phone Number Dialing:

1. The dialer shall be a solid state component capable of dialing up to 16 phone numbers, each up to 24 digits in length. Phone numbers and Standard pulse dialing or Touch Tone DTMF dialing are user programmable via the system's keyboard or Touch Tone phone.

Solid State Voice Message Recording and Playback:

2. The unit shall have two different categories of speech message capability, all implemented with permanent non-volatile solid state circuitry with no mechanical tape mechanisms. The unit shall allow for message recording from a remote telephone as well as from the front panel.

** User Field Recorded Messages: The user may record and re-record his own voice messages, for each input channel and for the Station ID.

A. There shall be no limit on the length of any particular message, within the overall available message recording time, which shall be 40 seconds for 4 channel units; 80 seconds for 8 channel units.

B. The unit shall allow selective recording of both Normal and Alarm advisory messages for each input channel.

C. The unit shall provide for automatic setting of the optimum speech memory usage rate for the total set of messages recorded, in order to achieve optimum recording sound quality.

D. Circuit board switches or jumper straps shall not be acceptable means of manipulating message length or recording rates.

** Permanent Resident Non-Recorded Messages: Permanent built-in messages shall be included to support user programming operations, to provide supplemental warning messages such as advising that the alarms have been disabled, and to allow the unit to be fully functional even when the installer has not recorded any messages of his own.

Local & Remote Programming Capabilities:

3. The user may optionally elect to alter the following parameters from their standard normal default values via keyboard entry or remotely from any Touch Tone phone.

** Alarm Call Grouping: On alarm, system shall selectively call the correct phone numbers according to the current alarm(s).

** Alarm response delay: .1 to 999.9 seconds.

** Delay between alarm call outs: .1 to 99.9 minutes.

** Alarm reset time: 0.1 to 99 hours or "NO RESET".

** Incoming ring response (answer) delay: 1 to 20 rings.

** Number of message repetitions: 1 to 20 repetitions.

** Input alarm criteria: Each channel shall be independently configured for "Alarm On Open Circuit", "Alarm On Closed Circuit", "No Alarm".

** Autocall Test: When enabled, the unit shall place a single round of test calls, both at the time this function is enabled and also at regular subsequent intervals until this function is disabled at the keyboard.

** Run Time Meter: Selected inputs shall accumulate and report the number of hours that its input contacts have been closed.

** Remote system microphone activation.

** Remote and local arming and disarming of system.

** Pulse Totalizer Function.

Nonvolatile Program Memory Retention:

4. User-entered programming and voice messages shall be kept intact even during power failures or when all power is removed for up to ten years.

Acknowledgement:

5. Acknowledgement of an alarm phone call is to be accomplished by pressing a Touch Tone® "9" as the alarm call 's being received, and/or by returning a phone call to the unit after having received an alarm call.

Input Monitoring Function:

6. The unit shall continuously monitor the presence of AC power and the status of four contact closure inputs (Model VBS-4C), or eight contact closure inputs (Model VBS-8C). AC power failure, or violation of the alarm criteria at any input, shall cause the unit to go into alarm status and begin dial-outs. Unit shall, upon a single program entry, automatically accept all input states as the normal non-alarm state, eliminating possible confusion about Normally Open versus Normally Closed inputs. Further, as a diagnostic aid, unit shall have the capability of directly announcing the state of any given input as currently "Open Circuit" or "Closed Circuit," without disturbing any message programming. Each input channel shall also be independently programmable, without need to manipulate circuit board switches or jumpers, as Normally Open or Normally Closed, or for No Alarm (Status Only), or for Pulse Totalizing, or for Run Time Metering.

Run Time Meter Inputs:

7. Any dry contact input can be programmed to accumulate and report the number of hours their respective input circuits have been closed. Any such channels will never cause an alarm, but on inquiry will recite the channel's message according to the status of the input and then report the closed circuit time to the tenth of an hour. The input will accumulate and report in tenths of hours up to a total accumulated running time of 99,999.9 hours. The initial value of the Run Time Meter shall be programmable in order to agree with existing electromechanical Run Time Meters. Up to a total of 8 Run Time Meters may be programmed.

Pulse Totalizer Inputs:

8. Any dry contact input can be programmed to accumulate the number of pulses (momentary contact closures) occurring at the input.

Alarm Message:

9. Upon initiating an alarm phone call, the system is to "speak" only those channels that are currently in "alarm status".

Diagnostics:

10. The unit shall provide a complete verbal report of all programmable functions and their programmed values on command form any remote Touch Tone phone.

Speakerphone:

11. The unit shall be capable of dialing any phone number on command and function as a speakerphone.

Inquiry Message and Function:

12. Inquiry phone calls can be made directly to the unit at any time from any telephone, locally or long distance, for a complete status report of all variables being monitored, including power status.

Power Battery Backup:

13. Normal power shall be 105-135 VAC, 15 watts nominal. The product is to contain its own gel cell rechargeable battery which is automatically kept charged when AC power is present. The system shall operate on battery power for a minimum of 20 continuous hours in the event of AC power failure. A shorter backup time shall not be acceptable. The built-in charger shall be precision voltage controlled, not a "trickle charger," in order to minimize recharge time and maximize battery life available.

Phone Line:

14. The dialer is to use a standard rotary pulse or Touch Tone "dial-up" phone line (direct leased line not to be required) and is to be F.C.C. approved. Connection to the telephone is through a 4-pin modular jack (RJ-11).

Integral Surge Protection:

15. All power, phone line and dry contact inputs shall be protected at the circuit board to IEEE Standard 587, category B (6,000 volts open circuit/3,000 amps closed circuit). Gas tubes followed by solid state protectors shall be integral to the circuit board for each such line. Protectors mounted external to the main circuit board shall not be an acceptable substitute. The installer shall provide a good electrical ground connection point near the unit to maximize the effectiveness of the surge protection.

Warranty:

16. The dialer shall be covered by a three (3) year warranty covering parts and labor performed at the Factory.

Additional Features: Sealed Switches, LED Indicators, Alarm Disable Warning, TalkThrough:

18. All keyboard and front panel switches shall be sealed to prevent contamination. Front panel LED's shall indicate: Normal Operation, Program Mode, Phone Call in Progress, Status for each channel, AC Power Present, AC Power Failure, and Low, Discharging or Recharging Battery. On any Inquiry telephone call or On Site status check, the voice shall provide specific warning if no dialout phone numbers are entered, or if the unit is in the "alarm disable" mode, or if AC power is off or has been off since last reset. A built-in microphone shall allow anyone at a remote phone to listen to local sounds and have a two-way conversation with personnel at the dialer.

Special Order Items:

19. The following options shall be available on specific order:
    a) Nema 4X (sealed) enclosure.
    b) Thermostatically controlled heater.
    c) Local Alarm Relay Output (provides contact for local alarms).

Specifications subject to change without notice.

685 365

TABLE OF CONTENTS

V09.14.92

685 366

KEEP THIS FOR YOUR RECORDS

LIMITED WARRANTY

WARRANTY CERTIFICATE

Raco Manufacturing and Engineering Co Inc., Emeryville California warrants this product to be in good working order for a period of three years from the date of purchase as a new product. In the event of failure of any part(s), due to defect in material or workmanship occurring within that three year period, Raco will, at its option, repair or replace the product at no charge for parts or labor. Any alteration of the product without instruction from Raco's Engineering Department will automatically void this warranty. If alterations of the unit are authorized by Raco, please complete the authorization form in the Owners Manual and return the form to Raco to ensure the warranty. Under no circumstances will Raco be responsible for consequential or secondary damages.

The defective product should be returned, insured and freight prepaid, securely packaged to the address listed below. Please call 1-800-722-6999 for a Return Authorization Number. Please include a copy of your sales receipt, the dialers serial number, and a detailed description of the problem you are experiencing.

Raco Manufacturing and Engineering Co Inc.
Service Department
1400 62nd Street
Emeryville, CA 94608

Detach here before mailing

WARRANTY REGISTRATION

IMPORTANT: Within 14 days of purchase, please compete this Warranty Registration. Detach the top portion, fold in half and drop in the mail. Postage is paid if mailed in the US. Otherwise, please return to:

Raco Manufacturing and Engineering Co Inc.
1400 62nd Street
Emeryville, CA 94608

Model: Verbatim____________________
Serial Number____________________
Date of Purchase____________________
Name____________________
Title/Position____________________
Company/Organization____________________
Division/Department____________________
Address____________________
____
Telephone____________________
Dealer's Name____________________
Address____________________
____

The following additional information will assist us in our continuing efforts to provide you with products that meet your specific requirements.

1. This autodialer is used in:___wastewater,___gas pipeline,___remote equipment ___cold storage,___chemical manufacture, ___energy generation, ___agriculture, ____________other.
2. It uses the following types of transducers: ___pressure, ___temperature, ___flow, ___electrical detection, ___gas (all types), ___intrusion, ___float level, ____________other.
3. I first became aware of this autodialer from: ___dealer showroom, ___ colleague, ___trade show, ___professional association, ___magazine inquiry, ___other.
4. I read the following publication(s) regularly:____________________

Please send me more information on the following quality products from Raco Manufacturing:

___Chatterbox CB-4/8
___Chatterbox CB-16,24,32
___Verbatim
___Remote Supervisory Control
___Analog Inputs
___Nema 4X enclosure
___Local Data Logging
___Central Data Logging
___Data Acquisition System
___Extended Warranty

NOTE: Unlike the current date entry (CODE 9 4 1) the day-of-week date cannot be entered.

CODE 965:

READ HOLIDAY DISARM DATE (default: 12/26/90)

Press 9 6 5 then (enter) to hear the Holiday DISARM date recited. The Holiday DISARM will not be altered.

SET HOLIDAY DISARM DATE

Press 9 6 5 plus REARM date. For Example, enter 965 12 26 91 (enter) to set holiday DISARM date to December 26, 1991.

NOTE: Unlike the current date entry (CODE 9 4 1) the day-of-week date cannot be entered.

CODE 966:

READ ALARM READY SCHEDULE CONTROL NUMBER (default: 0)

Press 9 6 6 then (enter) to hear the Alarm Ready Schedule Control Number recited. The Control number will not be altered and new REARM & DISARM values will not be calculated.

SET ALARM READY SCHEDULE CONTROL NUMBER

Press 9 6 6 C to set the Alarm Ready Schedule Control Number, where C is a control number described below.

ALARM READY SCHEDULE CONTROL NUMBER HAS THE FOLLOWING MEANING:

0 - OFF No Alarm Ready Schedules executed. Also used to reset any active Alarm Ready Schedules.

1 - Only the Weekday Alarm Ready Schedule will be active. (Daily: Monday-Sunday)
Default: REARMED everyday 1700 & DISARMED everyday 0800.

2 - Only Weekend Alarm Ready Schedule will be active.
Default: REARM every Friday 1700 & DISARM every Monday 0800.

3 - Both Weekday & Weekend Alarm Ready Schedules will be active.
Default: REARM daily at 1700 Monday-Thursday & DISARM daily at 0800 Tuesday-Friday. REARM Friday at 1700 & DISARM Monday at 0800.

4 - Only Holiday Alarm Ready Schedule will be activated.
Default: REARM at 1700 December 24, 1990 then DISARM at 0800 December 26, 1990

5 - Both Holiday & Weekday Alarm Ready Schedules will be activated.
Default: REARM daily at 1700 & DISARM daily at 0800.
REARM at 1700 December 24, 1990 then DISARM at 0800 December 26, 1990.

6 - Both Holiday & Weekend Alarm Ready Schedules will be activated.
Default: REARM every Friday at 1700 then DISARM every Monday at 0800.
REARM at 1700 December 24, 1990 then DISARM at 0800 december 26, 1990.

7 - Holiday, Weekend & Weekday Alarm Ready Schedules will be activated.
Default: REARM daily at 1700 Monday-Thursday then DISARM daily at 0800 Tuesday-Fri.
REARM every Friday at 1700 then DISARM every Monday at 0800.

REARM at 1700 December 24, 1990 then
DISARM at 0800 December 26, 1990.

NOTE: Whenever a new Alarm Ready Schedule Control Number is entered all REARM & DISARM values will be recalculated. Any active Alarm Ready Schedules will be halted and the Verbatim will be left in which ever REARM/DISARM state it was last in.

FACTORY DEFAULTS

Weekday REARM time	1700
Weekday DISARM time	0800
Weekend REARM day-of-week	Friday
Weekend DISARM day-of-week	Monday
Weekend REARM time	1700
Weekend DISARM time	0800

NOTE: Both Weekend times are initially the same as their respective Weekday times but are settable by operator.

Holiday REARM date	12/24/90
Holiday DISARM date	12/26/90
Holiday REARM time	always same as Weekend REARM time
Holiday DISARM time	always same as Weekend DISARM time
Alarm Ready Control Number	0 (all schedules disabled)

WEEKDAY AND WEEKEND ALARM READY SCHEDULE PROGRAMMING EXAMPLE

For the following example assume there are personnel present at a plant being monitored by the Verbatim during normal business hours, Monday through Friday, 7 A.M. to 4 P.M. And that there is someone at the plant every Saturday from 7 A.M. until 12 Noon. Therefore, those personnel would be aware of any alarm conditions at the plant and would <u>not</u> want the Verbatim to be making calls to phone numbers in it's phone number list. Then the Verbatim should become REARMED every weekday evening at 1600 and become DISARMED every weekday morning at 0700. Also, the Verbatim should become REARMED every Saturday at 1200 noon and stay in the ARMED state until it is DISARMED every Monday at 0700.

Step 1) Make sure the current time is during one of the times when the Verbatim should be DISARMED, ie; during the workday hours. This is necessary since any Alarm Ready Schedule begins with the Verbatim becoming REARMED and ends with the Verbatim becoming DISARMED. If the user were to set up a repeating Alarm Ready Schedule (weekday or weekend) during the time the Verbatim was to be ARMED, the programmed schedule would not actually begin until the next time that schedule was to take effect. For example, if the current time was 1630 and a weekday schedule was being programmed, that weekday schedule would not actually start until the next day at 1600.

Step 2) Press the "PROGRAM" key to put the Verbatim into the program mode.

Step 3) Set the current date and time: (if not already set)
Enter CODE "941 MM DD YY d" followed by "enter"
Where MM = 2 digits for month, DD = 2 digits for date,
YY = 2 digits for year, and d = 1 digit for day-of-week.
Enter CODE "942 HH MM SS" followed by "enter"
Where HH = 2 digits for hours, MM = 2 digits for minutes,
SS = 2 digits for seconds.

Step 4) Set the Weekday REARM/DISARM times:
Enter CODE "961 1600 0700" followed by "enter"
to set the REARM time to 1600 and the DISARM time to 0700.

Step 5) Set the Weekend REARM/DISARM times:
Enter CODE "962 1200 0700" followed by "enter"
to set the weekend REARM time to 1200 and the weekend DISARM time to 0700.

Step 6) Set the Weekend REARM/DISARM day-of-week:
Enter CODE "963 7 2" followed by "enter" to set the weekend REARM day-of-week to Saturday and the Weekend DISARM day-of-week to Monday.

Step 7) Enable both the Weekday and Weekend Alarm Ready Schedules:
Enter CODE "966 3" followed by "enter" to set the Alarm Ready Schedule Control Number to 3 and enable both the Weekday and the Weekend Alarm Ready Schedules.
Note: If the Verbatim is configured with a local printer a summary of all of the REARM and DISARM times will be printed.

Step 8) Return to the Normal mode and make sure the Verbatim is DISARMED.

685 370

TIME AND DATE SETTING:

Use Program Code 935 7 ENTER to start the real time clock chip. This needs to be done only once at the time of the installation of the chip.

Time and date may be set or corrected with the following programming code entries:

941 ENTER to check the date.

941 MM DD YY D ENTER to set the date.

MM is the month (03 for March); DD is the date (07 for the 7th day of the month); YY is the year (89 for 1989); and D is the day of the week (1 for Sunday; 2 for Monday, etc.). Entry of D is optional.

942 ENTER to check the time.

942 HH MM SS ENTER to set the time.

HH are the hours in military time (13 for 1 PM); MM are the minutes (09 for 9 minutes); and SS are the seconds. Entry of SS is optional.

935 7 ENTER clears the time and date back to 00:00:00 on 01/01/89.

Therefore, if personnel regularly leave early on Fridays then the REARM time could be set to 1500 instead of the usual 1700.

Weekday Schedule Mode

The weekday schedule will REARM the Verbatim daily at the programmed weekday REARM time and DISARM the Verbatim daily at the programmed DISARM time. If no weekend schedule is enabled (via the Alarm Ready Control Number settings) then the weekday schedule applies everyday, Monday through Sunday. As noted below, the weekend schedule is overridden by the weekend and holiday schedules.

Alarm Ready Schedule Priorities

There is a priority among the Alarm Ready Schedules. The Holiday Alarm Ready Schedule has the highest priority, then comes the weekend schedule and finally the weekday schedule.

If all three Alarm Ready Schedules are to be active, a Holiday schedule will always start at it's scheduled time & date regardless of the state of the other schedules. When the Holiday schedule is over then the other schedules will resume.

Likewise, the Weekend Alarm Ready Schedule has priority over the Weekday Alarm Ready Schedule. The weekend schedule will always start at it's programmed day-of-week and time regardless of the state of the weekday schedule. When the weekend schedule is over then the weekday schedule will resume.

Programming Alarm Ready Schedule Parameters

The following section explains the VERBATIM codes to be used for programming Alarm Ready Schedules and the Alarm Ready Schedule Control Numbers. Alarm Ready Schedule Schedules parameters may be entered either at the front panel or over the phone.

There are some restrictions which must be remembered when entering DISARM/REARM times and ALARM READY SCHEDULE CONTROL NUMBERS. First, it is not generally possible to "jump" into a schedule when exiting the programming mode. For example, if the current time is 1700 hours and the operator enters a weekday schedule to REARM daily at 1630 and DISARM daily at 0730, this new schedule would not start until the following day at 1630 hours. There is one exception to this rule; if again it is 1700 hours and the operator enters a schedule to REARM at 1705 and DISARM at 0800 then continues doing other programming of the Verbatim until after 1705, when the operator returns the Verbatim to the Normal mode the Verbatim would be REARMED for the weekday schedule.

Second, you cannot enter any holiday date values which will cause the holiday REARM or DISARM date and time to be earlier than the current date and time. As explained below, the holiday schedule uses the weekend times for the time-of-day of the holiday REARM and DISARM.

Finally, it's useful to understand that the Verbatim's internal count-down timers used for REARM/DISARM times are re-calculated as a result of the operator making certain Alarm Ready Schedule programming changes. Anytime a new REARM or DISARM date/time is entered, a calculation is made to determine the next REARM and DISARM for that particular schedule. Also, when the ALARM READY

SCHEDULE CONTROL NUMBER is changed all REARM and DISARM date/times are re-calculated. Further, whenever the current date or time is set or changed by the operator all REARM and DISARM date/times will be re-calculated.

CODE 961:
READ WEEKDAY REARM & DISARM TIME (defaults: 1700 & 0800)
Press 9 6 1 then (enter) to hear the Weekday REARM & DISARM times recited. Times will not be altered and new REARM & DISARM values will not be calculated.
SET WEEKDAY REARM & DISARM TIME
Press 9 6 1 plus REARM & DISARM time.
For example, 961 1600 0700 then (enter) to set REARM time to 1600 (4:00 P.M.) & DISARM time to 0700 (7:00 A.M.) The user is allowed to enter just the REARM time, ie; 961 1600 (enter). But, if the user wants to change the DISARM time then both the REARM & DISARM times must be entered.
CODE 962:
READ WEEKEND REARM & DISARM TIME (defaults: 1700 & 0800)
Press 9 6 2 then (enter) to hear the Weekend REARM & DISARM times recited. Times will not be altered and new REARM & DISARM values will not be calculated.
SET WEEKEND REARM & DISARM TIME
Press 9 6 2 plus REARM & DISARM time then (enter)
For example, 962 1500 0700 then (enter).
to set REARM time to 3:00 P.M. & DISARM time to 7:00 A.M.
The user is allowed to enter just the REARM time, ie; 962 1500 (enter). But, if the user wants to change the DISARM time then both the REARM & DISARM times must be entered.
CODE 963:
READ WEEKEND REARM & DISARM DAY-OF-WEEK (defaults: Fri. & Mon.)
Press 9 6 3 then (enter) to hear the Weekend REARM & DISARM day-of-week recited as a number from 1 to 7.
Note: Sunday = 1, Monday = 2, etc. Day-of-week will not be altered and new REARM & DISARM values will not be calculated.
SET WEEKEND REARM & DISARM DAY-OF-WEEK
Press 9 6 3 plus REARM & DISARM d-o-w then (enter).
For example, 963 6 1 then (enter) to set the weekend REARM day-of-week to Friday & REARM day-of-week to Sunday.
The user is allowed to change only the REARM d-o-w if so desired, eg; 963 7 (enter) to set the REARM d-o-w to Saturday. But, if the user wants to change the DISARM d-o-w then both the REARM d-o-w & DISARM d-o-w must be entered.
CODE 964:
READ HOLIDAY REARM DATE (default: 12/24/90)
Press 9 6 4 then (enter) to hear the Holiday REARM date recited. The Holiday REARM will not be altered.
SET HOLIDAY REARM DATE
Press 9 6 4 plus REARM date. For example, enter 964 12 24 91 (enter) to set holiday REARM date to December 24, 1991.

REMOTE ALARMS AND CONTROLS

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SUPPLEMENTAL INSTRUCTIONS FOR THE ALARM READY SCHEDULE FEATURE

DEFINITION

An Alarm Ready Schedule is defined as an interval of time during which the Verbatim is ARMED and "Ready" to respond to alarm conditions. Alarm Ready Schedules can be automatically started according to times and dates entered by the operator. An Alarm Ready Schedule commences with the Verbatim becoming REARMED. (If the Verbatim was previously not DISARMED then the schedule will still be commenced at that time.) Once the Alarm Ready Schedule has commenced the Verbatim will continue in an ARMED state until the end of the Alarm Ready Schedule, at which time the Verbatim will be automatically DISARMED. Once an Alarm Ready Schedule has commenced it is said to be "active".

NOTE: Please review the section of the Verbatim Owner's Manual on the topic of Date/Time entry.

GENERAL DESCRIPTION

Alarm Ready Schedules can be viewed as really nothing more than an automated way of pressing the REARM/DISARM button. Therefore, if an alarm occurs while the Verbatim is DISARMED, no dial-outs will be made and the alarm will be automatically acknowledged. Correspondingly, if there is an acknowledged alarm when the VERBATIM becomes REARMED and the input violation is still present then the Verbatim will begin calling after the trip delay has elapsed.

If the Verbatim is doing a sequence of alarm calls or autocall calls at the time when an Alarm Ready Schedule should change the Verbatim's REARM/DISARM state the change will be delayed until after the end of the calling sequence.

Alarm Ready Schedules can be temporarily overridden by the operator pressing the REARM/DISARM button. However, if the REARM/DISARM button is pressed during an active Alarm Ready Schedule the schedule still remains active. If the operator DISARMs the Verbatim in the middle of an Alarm Ready Schedule the schedule will actually continue as if it were timing an ARMED period(but it is of course DISARMED). It will then switch to the DISARM period and attempt to DISARM the Verbatim just as if the Verbatim was still ARMED. At this point it will be back on its normal sequence. If the operator DISARMs the Verbatim in the middle of an active Alarm Ready Schedule then REARMs the Verbatim once again before the end of the ARMED period, the schedule will maintain the ARMED period until it's scheduled ending time. The schedule will then DISARM the Verbatim.

Alarm Ready Schedule Modes

There are three possible Alarm Ready Schedules modes: Weekday, Weekend & Holiday. Any combination of these three possible schedules may be enabled at one time. However, the Verbatim may only become REARMED or DISARMED by one mode at a time. (See Alarm Ready Schedule Priorities below.) For example, you may have both weekday & weekend schedules enabled at the same time or you may have all three enabled at the same time. When the Verbatim becomes DISARMED or REARMED by an Alarm Ready Schedule it will verbally announce which mode caused the REARM/DISARM action. The Alarm Ready Schedule modes are as follows:

Mode 1 - Weekday Schedule
Mode 2 - Weekend Schedule
Mode 3 - Holiday Schedule

For example, if there was a weekday schedule enabled to REARM the Verbatim at 1700 daily, when the weekday schedule became active the Verbatim would say, "REARMED for mode 1". Also, when there is a local printer connected to the Verbatim, the mode of the Alarm Ready Schedule causing the REARM/DISARM (WEEKDAY, WEEKEND, or HOLIDAY) will be printed along with the current time.

Holiday Schedule Mode

The Holiday schedule is a one-shot, non-recurring schedule which overrides all of the other schedules.

The Holiday schedule will be set by factory default to some Holiday period in the past (such as last Christmas). For the Holiday schedule only, the exact date is entered including the year. Once, the Holiday schedule has been run it is complete and finished until a new schedule, for some date in the future, is entered.

To use the Holiday Alarm Ready Schedule, the operator must enter the REARM date (month/date/year) and DISARM date (month/date/year). For the time-of-day, the Holiday Alarm Ready Schedule always uses the Weekend REARM/DISARM times.

Weekend Schedule Mode

The weekend schedule, if programmed, operates once a week. The weekend schedule is set by factory default to be Friday through Monday unless changed from these defaults. If the defaults are used the Verbatim could be REARMED every Friday afternoon at 1700 and DISARMED again every Monday morning at 0800. The weekend schedule could be changed from the defaults, for example, so that the Verbatim would be REARMED on Saturday and DISARMED on Monday (for organizations with 6 day work-weeks).

When the weekend schedule is enabled the weekday schedule will be overridden. In other words, there would be no DISARMING of the unit at 0800 Saturday morning.

By default, the weekend REARM/DISARM times are set to be the same as the weekday REARM/DISARM times. However, non-default weekend REARM/DISARM times may be entered if the operator so chooses.

SECTION 1. PRODUCT DESCRIPTION AND SUMMARY OF THIS MANUAL

PRODUCT DESCRIPTION

The VERBATIM® Voice Recording Autodialer functions as a remote alarm monitor, typically monitoring critical facilities which are not staffed 24 hours a day.

The VERBATIM® Basic series autodialer monitors 4 or 8 inputs from user-supplied external sensors, such as float switches, limit switches, etc. These sensors are usually dry, isolated contacts which close or open to indicate the sensed condition.

When any of the external sensors indicate an alarm condition, or when AC power fails, the VERBATIM® autodialer accesses the standard phone line to which it is connected, dialing the appropriate phone numbers and delivering the user's own pre-recorded voice message corresponding to those particular alarm conditions that are currently active. Dialing continues repeatedly through the entire list of up to 16 programmed phone numbers, until the alarm is acknowledged by touch tone command or by calling the VERBATIM® autodialer back.

The VERBATIM autodialer incorporates many flexible, voice-supported programming and message recording options, to meet a wide range of user requirements. Yet, in most cases the user may rely on pre-existing default programmed parameters, greatly simplifying programming. Even default voice alarm messages are provided.

ALL USER PROGRAMMING AND VOICE MESSAGE RECORDING MAY BE ENTERED, REVIEWED OR CHANGED EITHER FROM THE FRONT PANEL OR FROM A REMOTE TELEPHONE AT ANY TIME. THUS, INSTALLATION AND PROGRAMMING MAY EASILY BE DONE BY SEPARATE PERSONNEL AT SEPARATE TIMES. Most programming is entered in the form of 3-digit codes as described herein. All user programming, including recorded messages, is maintained in permanent non-volatile memory.

Individual standard contact inputs may be optionally programmed to report status only or to accumulate run times, or even to totalize pulses from flowmeters, etc.. In most cases, the outputs of logic controllers may be connected directly to standard contact inputs without need for interfacing relays.

The VERBATIM autodialer incorporates extremely thorough and effective electrical surge protection and overall rugged construction, to deliver reliable operation under real-world conditions.

SUMMARY OF THIS MANUAL

This manual guides you through the following procedures:

- LOCATION AND MOUNTING
- INITIAL PROGRAMMING
- VOICE MESSAGE RECORDING
- USING YOUR PROGRAMMED VERBATIM AUTODIALER
- ADVANCED PROGRAMMING

A glossary explaining the terms used herein is included the end of the manual, along with a troubleshooting guide, an index, and FCC notice to users. Worksheets are provided to document and clarify your programming and message recording steps.

Please take a moment to read, complete, and mail the warranty card at the front of this manual.

685 376

SECTION 2. INSTALLATION

STEP 1: LOCATION AND MOUNTING

Choose a mounting location which is not exposed to condensing humidity or temperatures beyond the limits of 20°130°F. This location should ideally be within 5 feet of a standard RJ-11 phone jack and a GROUNDED 120 VAC power outlet.

Mount the dialer on centers of 6" x 11 3/8" using the external mounting ears on the enclosure. #10 or 3/16" bolt sizes are best.

An optional NEMA 4X weatherproof outer enclosure is available. This allows the dialer to be mounted outdoors as long as temperature limits are not violated. It is best to provide at least an overhead shelter to minimize direct precipitation and solar heating effects.

An optional heater/thermostat is also available for cold or humid environments. The 120 vac heater dissipates 75 watts, providing a temperature rise of approximately 30 degrees, or 60 degrees when enclosed in the optional NEMA 4X enclosure.

STEP 2: WIRING (Refer to the diagram)

Inspect and remove any foreign materials which might create short circuits.

Connect the red (positive) battery lead to the positive terminal on the gel-cell battery.

Plug the power cord into a GROUNDED 120 VAC OUTLET. Or, remove the power cord from the dialer and install well-grounded 120 VAC power to terminal strip TS3, located on the lower right of the main circuit board. If there are any green grounding wires in place on TS3 originating from plug-in expansion cards, leave those green grounding wires in place on the terminal marked GREEN. If the dialer turns on when power is applied, turn it off with the red ON/OFF key.

Connect dry (unpowered) contacts to the terminal strip connection points. The connection point for basic four-channel units is terminal strip TS1, located on the lower left of the main circuit board. Note that there are four common return terminals marked "C"; any combination of these internally grounded terminals may be used. TS1 is un-plugable for convenience. All terminal points are screw clamp type, eliminating the need for wire termination lugs.

The contact input wires should ideally be light (18 to 24 gauge) signal wire rather than heavy power wire. This reduces problems of bulk and stiffness.

Units with 8 or more inputs have a VX32 Channel Expansion Card plugged into connector J4. If your unit has this card installed, then use TS1 for common return connections only, and connect one side of each contact to the appropriately marked channel input number on the VX32 card. Leave TS1 terminals 1,2,3 and 4 unconnected. Note that the common "return" side of the contacts will need to be consolidated into not more than four wires coming into the TS1 terminals marked "C". ROUTE THE WIRES TO THE VX32 CARD SO THAT THEY DO NOT PROTRUDE ABOVE THE TOP OF THE CARD, otherwise they will interfere with the front panel board when the door is closed.

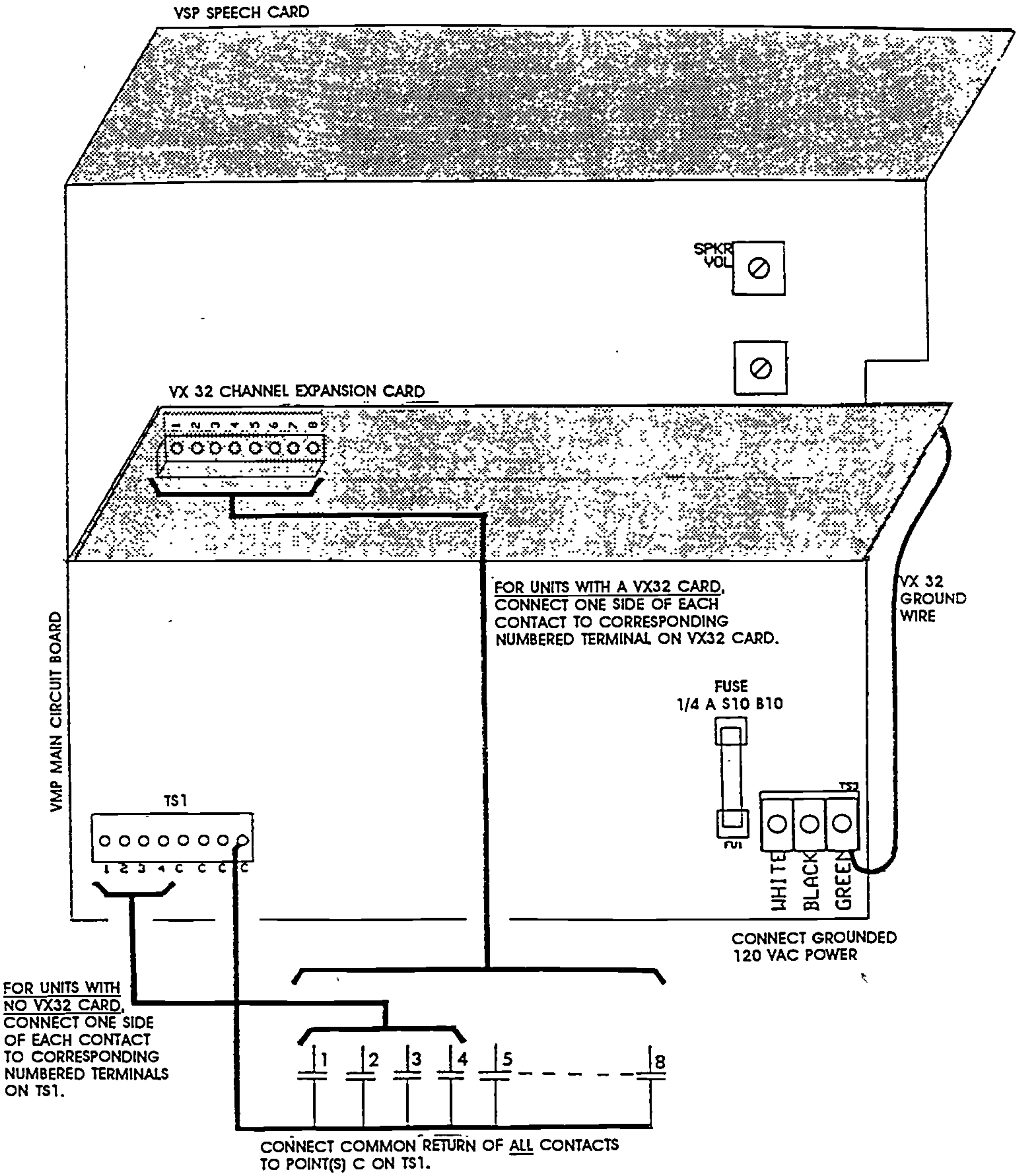
IN ALL CASES, BE SURE THAT THE CONTACT INPUTS ARE "DRY" AND DO NOT PROVIDE POWER OF THEIR OWN, OR THE DIALER WILL BE DAMAGED!

Note that terminal strip TS1, and the terminal strips on the VX32 card if any, are un-plugable. Be sure that wire stresses do not result in a terminal strip becoming unplugged when the door is closed, etc.

SPECIAL CASE:

If your inputs are coming from a logic controller with TTL, CMOS or 5-volt DC logic outputs, direct connection may be made as long as the controller has the same electrical ground as the dialer. If higher-voltage DC levels exist, use diodes in series with the dialer inputs, with the cathode (banded end) toward the source. In all cases, a low (0) logic level will be interpreted by the dialer as a closed circuit input.

VERBATIM ELECTRICAL CONNECTION DIAGRAM 2/1/89



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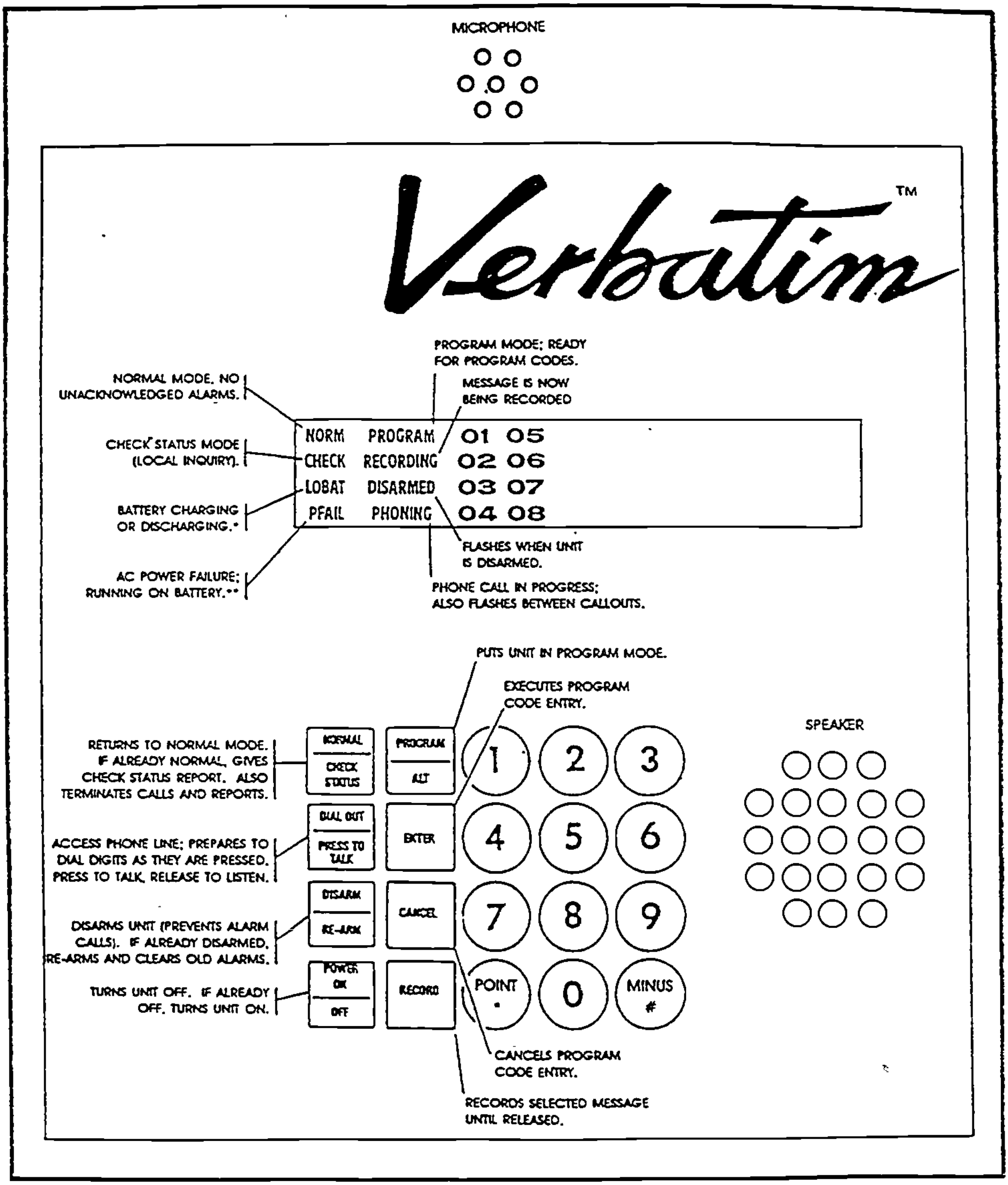


* With a fully charged battery, light should go out within a few minutes of turning on. A discharged battery may take up to a day to fully recharge.

** During AC power failure, all illuminated LEDs will flash to conserve battery power.

SECTION 3. INITIAL BASIC PROGRAMMING AND TESTING

3.1 STEP 1: RESETTING (CLEARING) THE UNIT

First press PROGRAM. This puts the dialer in the Program Mode, as indicated by the lighted program legend. <u>All programming operations must be done with the unit in the Program Mode</u>.

<u>CAUTION: The following step erases all user programming including recorded messages</u> so normally it is done only at initial startup.

To clear the system memory, press:
9 3 5 9 ENTER

If you make an error in code entry, press CANCEL and start again.

3.2 STEP 2: PROGRAMMING PHONE NUMBERS

Refer to PROGRAMMING WORKSHEET A. You are encouraged to write down the phone numbers you want to program, along with a person's name for each phone number.

To program the first dial-out phone number, press:
7 01 (then the complete phone number) ENTER

For example, to program 1 (415) 658-6713 as the first phone number, press:
7 01 1 4 1 5 6 5 8 6 7 1 3 ENTER

To program a second phone number, use code 7 02 instead of 7 01, progressing to a maximum of code 7 16 for the 16th phone number.

Each number may be up to 24 digits in length. Be sure to include any necessary area codes or "1" prefixes.

SPECIAL CASES:

If you need touch tone dialing, press:
9 01 1 ENTER

To go back to standard pulse dialing, press:
9 01 0 ENTER

To insert delays between dialed digits, press the MINUS key once for each one second delay desired in the phone number programming process.

Refer to SECTION 6. ADVANCED PROGRAMMING, for specialized programming such as "grouping" phone numbers with input channels, or to establish and use a "call forward" phone number, etc.

3.3 STEP 3: PROGRAMMING INPUT CHANNELS

Your verbatim autodialer needs to know whether its input channels are to be NORMALLY CLOSED (alarm on Open Circuit), or NORMALLY OPEN (alarm on closed circuit).

All contact inputs are initially set normally closed (i.e. they will alarm on Open Circuit). This is the default setting and, therefore, any Open Circuits, including any inputs left unconnected during installation, will appear as alarms until the inputs are programmed.

To automatically program the inputs, first make sure all inputs are in their NORMAL (non-alarm) state. Then press:
5 0 0 ENTER

The VERBATIM autodialer automatically examines all inputs and programs them to <u>alarm on the opposite input state</u> from their present status. This code 500 does not affect any channels that have been programmed for status only, Run Time Meter, or Pulse Totalizer function.

SPECIAL CASES:

In most cases, no further programming of contact inputs is necessary. However, the following configuration options are available:

To set an <u>individual</u> contact input for normally closed operation (i.e. to alarm on open circuit), press:
5 ZZ 1 ENTER

where ZZ is the 2-digit channel number you are programming. Be sure to always use a leading 0 for channels 1 through 9 to keep the channel number a two-digit entry.

To set an <u>individual</u> contact input channel for normally open operation (i.e. to alarm on closed circuit), press:
5 ZZ 2 ENTER

Do you want any of your inputs set to report status only, never causing an alarm dialout? If so, program each individual channel as follows:
5 ZZ 3 ENTER

Do you want any of your contact inputs set for the run-time meter function, never causing an alarm dialout but reporting the total accumulated hours that the input contact is closed? If so, program each channel as follows:
5 ZZ 4 ENTER (See SECTION 6.2.)

Do you want any of your contact inputs set for the Pulse Totalizer function? If so, refer to SECTION 6.2.

3.4 INITIAL TESTING

First, temporarily disarm the unit by pressing DIS-ARM/RE-ARM until the DISARM LED is flashing. This prevents the unit from dialing out.

Next, physically trip each sensing device in turn (manipulate float switches, relays, etc.) and verify that the corresponding input channel LED lights at the front panel, and then restore all sensors to their normal state. Now press DISARM/RE-ARM. This will clear out the channel input LEDs and restore the unit to a ready condition.

Finally, to test the phone line connection, with the unit's phone cord plugged into its phone jack, temporarily remove the AC power cord to the unit. The PFAIL LED will illuminate. At this point all illuminated LEDs will flash on and off in order to conserve battery power. Since the unit is not disarmed this time, after a 0.1 minute Alarm Trip Delay the PHONING light will illuminate and the unit will access the phone line and will begin dialing the first phone number.

The unit will recite its station ID and power failure messages. You may converse with the person answering by pressing and releasing DIALOUT/PRESS TO TALK. Press this key again when you wish to speak, and release this key to listen. This action will suspend message recital. In this case, when the conversation is done, you should end the call by pressing NORMAL. Ordinarily the alarm call would end automatically.

Now press DISARM/RE-ARM twice. This step disarms and then rearms the unit clearing all acknowledged alarms. This clearing also occurs automatically after the Alarm Reset Time has elapsed (default value 1 hour. See SECTION 5.6).

Your VERBATIM autodialer is now able to operate, having at least one dialout phone number programmed and having its input channels configured. However, you may wish to record your own voice messages (see the next section) or perform special advanced programming items (see SECTION 6) before referring to SECTION 5 on USING YOUR PROGRAMMED VERBATIM AUTODIALER.

SECTION 4. RECORDING MESSAGES IN YOUR OWN VOICE

Be sure to complete the programming of the input channels as described in the previous section before recording any messages.

Recording messages is an optional step. Your VERBATIM autodialer comes with built-in default normal and alarm messages for all channels, so **recording messages in your own voice can be postponed** if you so desire, until you have become more familiar with your unit. You may even choose to record or re-record your own messages from a remote telephone at any time.

Ordinary contact input channel default messages are "Channel N Normal" and "Channel N Alarm".

For "Status Only" and Run Time Meter programmed channels (never causing an alarm), the default messages are "Channel N is ON" when the input circuit is closed, and "Channel N is OFF" when the input circuit is open.

The default Station ID message is "ID Number One." The ID message is included in every phone call to identify the calling unit.

SPECIAL CASES:

Are any of your input channels programmed for status-only reporting or for run-time metering? (See SECTION 6.) If so, and if you wish to record your own messages for these specially configured channels rather than relying on the default "Channel N is on" or "Channel N is off" messages, plan a message for the Closed Circuit condition and another message for the Open Circuit condition for each channel. For Run Time channels the unit will add a report of the run time in hours, using built-in speech, at the end of the appropriate closed or open circuit message.

Are any of your input channels programmed for Pulse Totalizer function? If so, see SECTION 6.2 for special guidance in message planning and recording.

4.1 STEP 1: PLAN AND WRITE DOWN ALL YOUR MESSAGES

WORKSHEET C is provided to assist you with this. **Please use the worksheet!** Not only will you then have a written record of your messages for future reference, you will also then be prepared to record your messages with the greatest ease and efficiency.

In addition to the overall Station ID message, **two different messages are used for each contact input channel:** one message for the NORMAL CONDITION and another for the ALARM (fault) CONDITION. Many users can leave the existing default "Channel N is Normal" message in place rather than devoting recording time to the Normal Condition message for each channel. This leaves more recording time available for recording ALARM (fault) CONDITION messages for each channel.

When you have written down the messages that you want to record, you are ready for:

4.2 STEP 2: VERIFYING/EXTENDING THE TOTAL AVAILABLE RECORDING TIME

Do you need to extend the available recording time? Unless you have installed extra speech memory, the available recording time is:

"Initial" total recording time (at Rate 1):		Extendable to: (Rate 2, 3 or 4)
4 chan. unit	14 sec	21, 28 or 40 sec
8 chan. unit	28 sec	42, 56 or 80 sec

Initially, the unit is set for the fastest memory use rate ("Rate 1"), giving the highest fidelity sound recording. **If you are sure that your messages take less than the "Initial" time shown above for your unit (14 seconds total for a 4-channel unit), go on to step 3.** You may also verify your unit's current rate setting and corresponding total message recording time by pressing 9 1 1 ENTER.

If you need more time, or if you are not certain, the Verbatim autodialer's exclusive Autoextend™ feature will automatically extend the available recording time, selecting the optimum recording rate (speech memory rate) to give you the highest possible recording sound quality for your length of recording.

WARNING: The following step will erase any existing recorded messages.

To use the Autoextend™ feature to extend recording time, have your message worksheet handy as you press:

9 1 2 ENTER

The VERBATIM autodialer will prompt you to **immediately begin reciting your entire list of messages at the sound of the beep,** one after another, at the same speed that you will want to later record them.

During this time, **the VERBATIM autodialer will not be recording your spoken messages. Instead, it will be timing you.**

When you have finished reciting (not recording) the last message, **immediately** press ENTER.

Over the phone, press ZERO to start the timing, and ZERO again to end the timing. See SECTION 5.7, REMOTE OVER-THE-PHONE PROGRAMMING.

Based on how long your message recital took, **the Autoextend feature will automatically calculate** which recording rate is optimum for your length of recording time, **and will then automatically select that rate.** It will tell you how many seconds your message took, and how much total recording time it has now given you. Now you are ready for:

4.3 STEP 3: ACTUALLY RECORDING YOUR MESSAGES.

First, minimize any background sounds. Have your message worksheet in front of you and be prepared to recite the first ALARM (FAULT) CONDITION message **in a loud clear voice** within about 6 to 12 inches of the microphone located at the top of the front panel. Press:

1 ZZ ENTER

where ZZ is the appropriate 2-digit channel number, such as 01 for channel 1. Be sure to use leading zeroes, in order to keep ZZ a 2-digit entry. Use 00 for the Station ID message.

The voice specifically identifies the message you are about to record, and then prompts you to **press the record key and hold it just for the duration of your spoken message.** Note that the RECORDING light comes on during recording.

Over the phone, since there is no RECORD key, the voice will prompt you to press ZERO to begin recording, and press ZERO again to stop recording. (See SECTION 5.7.)

The VERBATIM autodialer will immediately play back the message you have just recorded, allowing you to determine if you need to re-record it louder, softer or more clearly, etc. Experiment with different volume levels to get the best message clarity. If there is too much background noise at the dialer site, record your messages over the phone.

Always stop the recording promptly to avoid wasting recording time.

To record an alternate "normal condition" message for channel ZZ, press:

2 ZZ ENTER

and follow the same procedure as above.

To review an existing message for channel ZZ, press:

3 ZZ ENTER

The VERBATIM autodialer will replay both existing messages for channel ZZ. This will include any default messages remaining in use.

SPECIAL CASES:

For any channels that you have programmed for "Status Only" or for Run Time Meter function, use code 1 ZZ for the Open Circuit message, and 2 ZZ for the Closed Circuit message.

If you run out of recording time, you will hear the message "No more message time". Go back to STEP 2 above to re-establish total available recording time. You may elect to shorten some messages, or rely more on selected default messages, or you may AUTOEXTEND the available recording time. Then, re-record all messages.

If you wish to extend the available time for a specific message while leaving the other messages unaffected, enter the code for recording that message, but add an extra digit 1 through 4, before pressing ENTER. The digit 1 (Rate 1) gives the shortest time and the best sound quality, while 4 (Rate 4) gives the longest time with poorest sound quality.

If you wish to reinstate a default message, enter the code for recording that message, and an extra POINT before pressing ENTER. For example:

1 ZZ POINT ENTER

If you wish to use the default Station ID message but with a different ID number in place of the "one", press

9 1 4 N ENTER

where N is the desired ID number which may be up to 24 digits long. Some users program the VERBATIM autodialer's own phone number as its ID number.

If you want to set a specific recording rate rather than letting Autoextend do it, press:

9 1 3 N ENTER

where N is the desired recording rate 1, 2, 3 or 4.

You will then need to re-record any messages that were previously recorded at a different rate.

SECTION 5. USING YOUR PROGRAMMED VERBATIM AUTODIALER

5.1 PLACING INQUIRY CALLS TO THE VERBATIM AUTODIALER

You may call the VERBATIM autodialer any time from any phone. After the programmed number of rings the unit will begin reciting a voice report, first giving its Station ID Message, then any special warning messages (such as not having any phone numbers programmed, unit is in the disarmed state, etc.), and then the status of each channel input. If there are no unacknowledged or acknowledged alarm conditions on any channel, then just before the status report the VERBATIM autodialer will say "All channels normal". If this call is acknowledging an unacknowledged alarm, the VERBATIM autodialer will say "Alarm is acknowledged".

The channel status report will be recited 3 times. Between each recital the VERBATIM autodialer will issue a prompting beep and then wait a few seconds for you to optionally enter a special Command Tone (see SECTION 5.7 below on over-the-phone programming). If you have not chosen to enter a tone, the unit will say "Goodbye" and terminate the call.

5.2 "CHECK STATUS" INQUIRY AT PANEL

When the NORM LED is lit, you may hear a report of current conditions by pressing the NORM/CHECK STATUS key. You may cut this report short by again pressing the NORM/CHECK STATUS key.

5.3 RECEIVING ALARM CALLS FROM THE VERBATIM AUTODIALER

When any input condition violates the alarm condition programming, and if that violation persists for the duration of the Alarm Trip Delay for that input, the unit goes into an Unacknowledged Alarm state and begins dialing the first of up to 16 programmed phone numbers. (See SECTION 6.1 on optional Alarm Call Grouping if you want the numbers dialed to depend on which channel is in alarm.) The corresponding channel alarm LED begins flashing to indicate an unacknowledged alarm.

The voice messages follow the same format as for an inquiry call, including the prompting beep, except that **channels that have no alarm activity are not included in the alarm report.** If there is no acknowledgement, the VERBATIM autodialer will repeat the message for the programmed number of repeats (default 3 repeats), then will say "Goodbye" and terminate the call.

If the alarm violation is corrected after the unit has gone into an Unacknowledged Alarm state, calling will not cease. However, the phrase "now normal" will be added at the end of each recital of the Alarm Condition message. Exception: For power failure alarms, when power is restored the message is "Power is on."

If the alarm has been acknowledged, the word "acknowledged" will be added.

These alarm messages will then continue to be included in any status reports until the Alarm Reset time expires.

If a channel is in violation but its Alarm Trip Delay has not timed out, the channel's alarm message will be recited, with the word "alert" added.

5.4 CONTINUED DIALING IN THE ABSENCE OF ACKNOWLEDGEMENT

The VERBATIM autodialer will then wait for the programmed Time Between Alarm Calls (default 2 minutes), during which you may call the VERBATIM autodialer back to acknowledge the alarm. If no acknowledgement is received at the end of this period, the next phone number will be dialed. The process will be repeated indefinitely, repeatedly going through all the designated phone numbers, until acknowledgement is received.

5.5 ACKNOWLEDGING THE ALARM CALL

To acknowledge the alarm during the alarm call, enter a touch tone "9" at the sound of the prompting beep. The VERBATIM autodialer will say "Alarm is acknowledged, Goodbye" and terminate the call. See SECTION 5.7 for additional ways of acknowledging an alarm without ending the call.

An alternate way to acknowledge the alarm is to wait for the alarm call to end, then call the VERBATIM autodialer back. At the front panel, pressing NORMAL, PROGRAM, DISARM, or DIALOUT will also acknowledge the alarm. Upon acknowledgement, the channel LED changes from flashing to steady illumination.

5.6 ALARM RESET TIMEOUT AFTER ACKNOWLEDGEMENT

Upon receiving an acknowledgement, the VERBATIM autodialer begins timing out the Alarm Reset Time, (default 1 hour).

Further calling on behalf of that channel is suspended, regardless of further activity at that particular input during this period. If new alarms occur on other channels during this period, the unit will go back into the Unacknowledged Alarm state and dial the first appropriate phone number, with dialing continuing until a new acknowledgement is received.

At the end of the Alarm Reset period the channel alarm LED turns off, the Acknowledged Alarm status is cleared for that particular channel input, and it is again ready to go into Unacknowledged Alarm whenever a violation occurs at that input. In particular, this means that if the violation had not been removed prior to the timeout, dialing will begin again immediately upon timeout of that Alarm Reset period.

It may be helpful to refer to the diagram 'Anatomy of an Alarm.'

5.7 REMOTE OVER-THE-PHONE PROGRAMMING

During any phone call (inquiry call or alarm call), at the end of each round of messages, the prompting beep is issued. If you press a Command Tone '1' at the sound of the beep, the VERBATIM autodialer will prompt you to enter a program code. (Or, if you have established a Security Access Code, you will first be prompted for this code). You may enter codes for most of the programming operations described in this manual except reading or changing the optional security access code.

Since some of the front panel keys are not found on a touch tone keypad, some special conventions apply for over-the-phone programming:

In Place Of:	Enter:
CANCEL	* *
ENTER	# #
POINT	*
MINUS	#

To end a phone call after programming, press # # without a prior digit entry. The VERBATIM autodialer will then issue a prompting beep which is an opportunity to re-enter a '1' if you didn't want to end the call. It will then say 'Goodbye' and end the call. Special exception: over the phone, you may not program more than one consecutive dialing delay, because # # (two in a row) is interpreted as ENTER when programming over the phone. However, you may extend this delay using code 928; see PROGRAM CODE table.

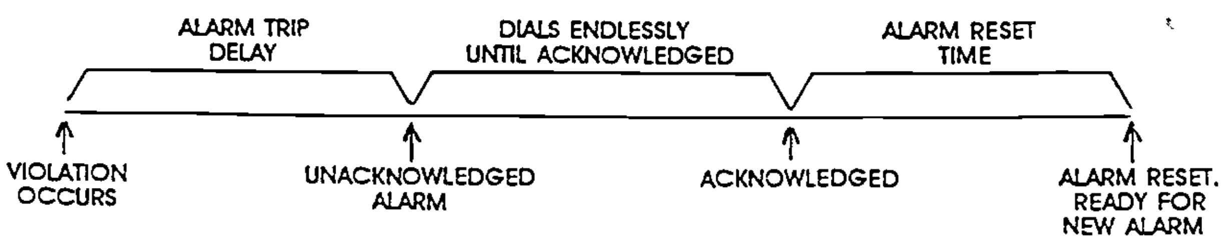
If you initially enter a Command Tone '2' in place of the '1', you will be in a special Program Review Mode, which allows you the safety of checking any of the programming items or messages, without the possibility of altering any of them.

If you initially enter a Command Tone '3' in place of the '1', you will hear a report of each channel that has any acknowledged or unacknowledged alarm condition.

If you initially enter a Command Tone '4' in place of the '1', you will hear a listing of all programmed phone numbers, plus any other basic programming items that you have altered from their default values. This is particularly useful in diagnosing operating problems.

If you initially enter a Command Tone '0' in place of the '1', the unit will immediately say 'goodbye' and end the phone call.

Note that if there is an unacknowledged alarm, entering any of these tones will also acknowledgethe alarm, in addition to their other primary functions.



ANATOMY OF AN ALARM

5.8 USING THE VERBATIM AUTODIALER TO DIAL OUT AND CONVERSE (SPEAKERPHONE)

At the panel, starting in the Normal Mode, press the DIALOUT/PRESS TO TALK key. Next press the digits of the phone number you want to dial. **Each digit you press will be dialed as you press it.** You will then hear the sound of the ringing. When you hear the phone answered, press and hold the same DIALOUT-/PRESS TO TALK key as you speak to the person on the line, and release the key to listen. Continue the conversation in this manner. To end the call press NORMAL. If the DIALOUT/PRESS TO TALK key remains unpressed for more than 2 minutes, the VERBATIM autodialer will automatically end the call.

To automatically re-dial a number that was previously manually entered by this method, press DIALOUT/PRESS TO TALK as before, then press ENTER rather than entering digits manually.

If you are at the panel when a phone call is in progress, you may suspend the message report and converse with the person on the other end by pressing the DIALOUT/PRESS TO TALK key as described above. There will be no additional dialing, since connection has already been established. To end the call, press NORMAL.

685 386

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SECTION 6. ADVANCED PROGRAMMING

6.1 COMPLETE LIST OF ALL PROGRAM CODES

The following table summarizes the wide variety of available programming operations, along with a description and comments. Additional information may be found in referenced notes below as well as in the referenced sections elsewhere in the manual.

When the overall programming is cleared out at initial startup, all programming is automatically set to factory default values as shown in the table. **Most of these default values are quite suitable for most users and only selected items may need to be programmed to different values.**

In general, entering a code and then ENTER without any intervening value reads the existing programmed setting without changing it. Also, in general, entering POINT after the code and before ENTER will clear program item, or will return it to its default value.

In this table several forms of numeric value entries are shown. They are:

- V — A value of one or more digits which may include a decimal point. Examples: .5, 2.8, 300.6, 60.
- N — One more digits giving a whole number; no decimal points allowed. Examples: 1, 5, 20.
- DN — A two-digit Designation Number for phone numbers (01 for first number, 02 for second, etc.).
- 1/0 — Used to turn a function ON (1) or OFF (0).
- ZZ — 2-digit channel number (use ZZ=00 for ID message).

NOTES FOR PROGRAMMING CODE TABLE:

1. ZZ = 2 digit channel number. Use ZZ=00 for Station ID message.
2. For any channels you have programmed as "Status Only" or "Run Time Meter", use code 1 ZZ for the Open Circuit message, use code 2 ZZ for the Closed Circuit Message. See SECTION 6.2 for message information for any Pulse Totalizer channels.
3. DN (Designation Number) is 01 for first dialout phone number, 02 for second number, etc. DN = 00 for special "callback" phone number. Use MINUS to insert any needed delays between digits. Each such delay is 1 second unless extended using code 928.
4. Actual power failure trip delay may be a fraction of a second longer than programmed value, due to power supply discharge time.
5. CAUTION: If Alarm Reset Function is turned OFF, acknowledged alarms will NEVER SELF CLEAR, preventing further alarm calls after acknowledgement for each channel.
6. Speaker always operates during front panel operations, even if turned off.
7. Cannot be read or changed over the phone.
8. Does not change channels that have been configured for "Status Only," "Run Time Meter," or "Pulse Totalizer."
9. CAUTION: High Speed Dialing setting may not work reliably with some telephone company exchanges.
10. Add POINT to restore default message.
11. To pre-set a Run Time value, include the value before ENTER.
12. Maximum value that can be entered is 4,294,967,294.
13. Omits all mention of disabled channel. Restore by setting for Normally Closed, Normally Open, etc.

CODE	DESCRIPTION AND COMMENTS	DEFAULT	RANGE	NOTE	SECTION
	CHANNEL STATUS READING				
0ZZ	Read status of channel ZZ				6.2
0ZZ0	Read actual open/closed ciruit status directly				6.2
	MESSAGE RECORDING AND REVIEWING				
100	Record Station ID Message			1, 2, 10	4.3, 6.2
1ZZ	Record channel ZZ ALARM message			1, 2, 10	4.3, 6.2
2ZZ	Record channel ZZ NORMAL message			1, 2, 10	4.3, 6.2
3ZZ	Review channel ZZ both messages (ZZ=00 for Station ID msg.)			1	4.3, 6.2
	Also see 911, 912, 913, 914 and SECTION 4 on messages				
	CHANNEL PROGRAMMING (CONFIGURATION)				
500	Sets current status as NORMAL for all channels	Norm Closed			3.3, 6.2
5ZZ	Reads alarm criteria for chan ZZ			1	6.2
5ZZ 1	Sets chan ZZ Normally Closed			1	3.3, 6.2
5ZZ 2	Sets chan ZZ Normally Open			1	3.3, 6.2
5ZZ 3	Sets chan ZZ for No Alarm (status report only)			1	3.3, 6.2
5ZZ 4	Sets chan ZZ for Run Time Meter Operation			1, 11	3.3, 6.2
5ZZ 6 N	Pulse Totalizer: set alarm setpoint N		Note 12		6.2
5ZZ 7 N	Pulse Totalizer: activate with starting value N (note 2)		Note 12		6.2
5ZZ 8 N	Pulse Totalizer: set scale factor N		Note 12		6.2
	ALARM CALL GROUPING				
5ZZ 9	Reads chan ZZ Alarm Call Grouping linkage			1	6.2
5ZZ 9 DN	Links chan ZZ to phone numbers DN			1	6.2
5ZZ 9 POINT	Clears channel ZZ linkage			1	6.2
	ALARM TRIP DELAYS				
600	Reads Power Failure Alarm Trip Delay				6.2
600 V	Sets Power Failure Alarm Trip Delay to V				6.2
6ZZ	Reads chan ZZ Alarm Trip Delay	2 sec	.1-999.9	1	6.2
6ZZ V	Sets chan ZZ Individual Alarm Trip Delay to V			1	6.2
6ZZ POINT	Returns chan ZZ Individual Alarm Trip Delay to 2 sec			1	6.2
902 V	Sets Global (all channels) Alarm Trip Delay to V	2 sec.	.1-999.9		6.2
	PHONE NUMBERS and PULSE/TONE DIALING				
7DN	Reads phone number DN (DN = 01 through 16)				3.2, 6.2
7DN N	Sets phone number DN to N (phone # up to 24 digits)			3	3.2, 6.2
7DN POINT	Clears out phone number DN				3.2, 6.2
928 N	Extends length of inserted dialing delays to N seconds	1 sec.	1-10		3.2, 5.7, 62

	MISCELLANEOUS PROGRAMMING ITEMS				
901 0/1/2	0=Pulse Dialing; 1=Tone Dialing; 2=High Speed Dialing	Pulse		9	6.2
902 V	Sets Global (all channels) Alarm Trip Delay to V	2 sec.	.1-999.9		6.2
903 V	Sets Time Between Callouts to V	2 min.	.1-99.9		6.2
904 V	Sets Alarm Reset Time to V	1 hour	.1-99.9		5.6, 6.2
905	Clears all acknowledged alarms; clears reset timers				6.2
906 N	Sets Ring Answer Delay to N (must be a whole number)	1 ring	1-20		5.1, 6.2
907 N	Sets number of Message Repeats to N (whole number)	3	1-20		5.3, 6.2
908 1/0	1 turns Autocall ON; 0 turns OFF	OFF			6.2
909 V	Sets Autocall Interval to V	24 hrs.	.1-99.9		6.2
910 N	Establishes a Security Access Code N (up to 8 digits)	None		7	6.2
911	Reads current recording rate and avail. recording time				4.2
912	Autoextend: sets optimum rec rate for recited messages				4.2
913 N	Sets Recording Rate	Rate 1	1-4		4.2
914 N	Inserts N in place of 1 in canned Station ID message	1			4.3
920 V	Power Failure Trip Delay (duplicates function of code 600)	0.1 min.	.1-999.9	4	6.2
921 1/0	1 turns Power Failure Alarm ON; 0 turns OFF	ON			6.2
922 1/0	1 turns Alarm Reset timers ON; 0 turns OFF	ON		5	6.2
924	Initiates test callback to phone # 00				6.2
926 V	Sets Delay Before Return to Normal (Exit Delay) to V	2 min.	1-99.9		6.2
928 N	Extends length of inserted dialing delays to N seconds	1 sec.	1-10		3.2, 5.7, 6.2
930 1/0	1 Arms unit for alarm callouts; 0 disarms	ARMED			6.2
932	Invokes one-time 15 second listening period				6.2
933 1/0	1 turns local Microphone ON; 0 turns OFF	OFF			6.2
934 1/0	1 turns Speaker ON; 0 turns OFF	ON		6	6.2
	CLEAROUT OPERATIONS				
935 0	Clears out phone numbers; sets all delays to default				6.2
935 1	Clears out phone numbers only				6.2
935 2	Clears out all Alarm Call Grouping linkage				6.2
935 3	Sets all delays to default values				6.2
935 4	Clears all user recorded messages				6.2
935 5	Clears all programming except messages				6.2
935 6	Clears all totalizers to 0 (not to preset) reading				6.2
935 9	Total clearout: ERASES ALL PROGRAMMING & MESSAGES				3.1, 6.2
	DIAGNOSTIC READOUTS				
940	Reads all 4 diagnostic counts (add 0 to clear all 4)				6.2
940 1	Reads Call In Count (add 0 to clear)				6.2
940 2	Reads Dial Out Count (add 0 to clear)				6.2
940 3	Reads Acknowledged Alarm Count (add 0 to clear)				6.2
940 4	Reads Power Falloure Alarm Count (add 0 to clear)				6.2

685 390

WORKSHEET B: ALARM CALL GROUPING PROGRAMMING

Used to "link" certain input chanels to call only selected phone numbers.

PART 1: As an organizational step, write in a Group Description Name (Electrical, Security, etc.) for each of your phone number groups, and the two-digit designation number of the phone numbers you want included in each group. Refer to the filled-in example below. This should be done only after you have already entered your entire list of up to 16 phone numbers on WORKSHEET A.

GROUP DESCRIPTION (Electrical, etc.)	2-DIGIT PHONE # DESIGNATION (taken from WORKSHEET A)

EXAMPLE:

GROUP DESIGNATION (Electrical, etc.)	2-DIGIT PHONE # DESIGNATION (taken from WORKSHEET A)
Maintenance	01, 04, 05, 06
Electrical	03, 04
Security	02, 05

PART 2: For each input channel that you wish to have "linked" to one of your groups, write in your chosen Group Description Name (Electrical, etc.), and the corresponding set of 2-digit Phone Number Designations which you established above. Finally, write in these same sets of 2-digit codes, without the separating commas, to the right of the printed program code (501, etc). This establishes the complete program code to enter for each channel that you want "linked" to call only a selected group of phone numbers.

Note that any channels that you do not enter such a program code for, will cause dialing of the entire list of phone numbers, when that channel goes into alarm.

CHAN	LINKED TO GROUP	CORRESP. PHONE # DESIG'S EST. ABOVE	PROGRAM CODE TO ENTER
01			501 9
02			502 9
03			503 9
04			504 9
05			505 9
06			506 9
07			507 9
08			508 9
09			509 9
10			510 9
11			511 9
12			512 9
13			513 9
14			514 9
15			515 9
16			516 9
17			517 9
18			518 9
19			519 9
20			520 9
21			521 9
22			522 9
23			523 9
24			524 9
25			525 9
26			526 9
27			527 9
28			528 9
29			529 9
30			530 9
31			531 9
32			532 9

EXAMPLE, FOLLOWING PART 1 EXAMPLE ABOVE:

CHAN	LINKED TO GROUP	CORRESP. PHONE # DESIG'S EST. ABOVE	PROGRAM CODE TO ENTER
01	Security	02, 05	501 9 02 05
02	Security	02, 05	502 9 02 05
03	Electrical	03, 04	503 9 03 04
04	Maintenance	01, 04, 05, 06	504 9 01 04 05 06
05	—	—	~~505 9~~
06	Electrical	03, 04	506 9 03 04
07	—	—	~~507 9~~
08	—	—	~~508 9~~
09			509 9
10			510 9
11			511 9
12			512 9
13			513 9
14			514 9
15			515 9
16			516 9
17			517 9
18			518 9
19			519 9
20			520 9
21			521 9
22			522 9
23			523 9
24			524 9
25			525 9
26			526 9
27			527 9
28			528 9
29			529 9
30			530 9
31			531 9
32			532 9

The above filled-in example is for an 8-channel unit. Three groups were established, and 5 of the channels were linked to a group. The remaining 3 channels were not linked to any group, and therefore, those 3 "unlinked" channels would dial the entire list of phone numbers in regular order.

6.2 COMPLETE DESCRIPTION OF ALL PROGRAMMING OPERATIONS

THE FOLLOWING DESCRIPTIONS SHOW THE RELEVANT PROGRAM CODES IN PARENTHESES, AND ARE ORGANIZED APPROXIMATELY ACCORDING TO THEIR APPEARANCE IN THE LIST OF PROGRAM CODES IN SECTION 6.1.

Refer also to section 5 for a description of over-the-phone programming, etc.

CHANNEL STATUS READING

(0 ZZ) READ STATUS OF CHANNEL ZZ
Plays the message that corresponds to the present input condition of channel ZZ.

(0 ZZ 0) READ OPEN/CLOSED CIRCUIT STATUS DIRECTLY
Says "Channel ZZ is closed" if channel ZZ input is presently closed circuit, or "Channel ZZ is open" if the input is open circuit. Useful in troubleshooting, especially at setup time.

MESSAGE RECORDING AND REVIEWING

Be sure to refer to Section 4 for important details on message recording, including for codes 911, 912, 913, 914.

(100) RECORD STATION ID MESSAGE

(1 ZZ) RECORD CHANNEL ZZ ALARM MESSAGE
Also used for Open Circuit message for channels programmed for NO ALARM (status only), or for Run Time Meter operation. Also used for preamble message for channels programmed for Totalizer function.

(2 ZZ) RECORD CHANNEL ZZ NORMAL MESSAGE
Also used for Closed Circuit message for channels programmed for NO ALARM (Status Only) or for Run Time Meter operation. Also used for "units of measure" portion of message which follows preamble and digit readings, for channels programmed for Totalizer function.

(3 ZZ) REVIEW CHANNEL ZZ MESSAGES
(Use 3 00 to review Station ID message)

CHANNEL PROGRAMMING (CONFIGURING)

Also see SECTION 3.3.

(500) SET PRESENT INPUT STATUS AS NORMAL CONDITION FOR ALL CONTACT INPUT CHANNELS
Used at setup time, as the most expedient way of programming the Normally Open/Normally Closed configurations ("Alarm Criteria") of contact input channels. Special configurations such as Status Only, Run Time Meter or Totalizer may then be programmed for specific individual channels. This code does not affect channels already programmed for Status Only, Run Time Meter, or Pulse Totalizer.

(5 ZZ) READ CHANNEL ZZ PROGRAMMING ("ALARM CRITERIA")

(5 ZZ 0) DISABLES CHANNEL FROM BEING MONITORED AND REPORTED

(5 ZZ 1) SET CHANNEL ZZ FOR NORMALLY CLOSED OPERATION
An Open Circuit condition will cause an alarm.

(5 ZZ 2) SET CHANNEL ZZ FOR NORMALLY OPEN OPERATION
A Closed Circuit condition will cause an alarm.

(5 ZZ 3) SET CHANNEL ZZ FOR NO ALARM (STATUS ONLY)

(5 ZZ 4) RUN TIME METER PROGRAMMING
You may program any of the ordinary input channels to accumulate and report the number of hours that their respective input circuits have been closed. Any such channels will never cause an alarm, but on inquiry will recite the channel's closed circuit message or the open circuit message according to the status of the input, and will then report the accumulated closed circuit time (run time) to the tenth of an hour.

To program channel ZZ for Run Time Meter operation, Press:

    5 ZZ 4 ENTER

To preset a starting value, press:

    5 ZZ 4 V ENTER

where V may be any value from 0 to 99,999.9.

To delete the Run Time Meter programming, use one of the other 500 series codes to reprogram the channel for the desired programming operation.

As with channels programmed for NO ALARM (Status Only) operation, the default Open Circuit message is "Channel N is off." To record your own Open Circuit message for channel ZZ, use program code 1 ZZ. The default Closed Circuit message is "Channel N is on." To record your own Closed Circuit message for channel ZZ, use program code 2 ZZ.

(5 ZZ 6, 5 ZZ 7, 5 ZZ 8, 935 6) PULSE TOTALIZER FUNCTION PROGRAMMING
The Totalizer function counts the accumulated number of pulses (momentary contact closures) occurring at the input for a channel which you have programmed for Totalizer operation. This function is typically used to accumulate the pulse output of rotary flowmeters.

An alarm setpoint may be programmed to create an alarm call upon reaching a particular total value. Scale and offset factors are programmable, and user-recorded messages may be used.

Any contact input channel may be programmed for the Totalizer function, up to a total of 8 Totalizers. The input pulse rate must not exceed 100 pulses per second, and if the rate is over 50 pulses per second, the pulses must have a 50% duty cycle.

To program channel ZZ for totalizer operation, press:
5 ZZ 7 ENTER.

To establish a non-zero starting value for the spoken reading, add the desired starting spoken value after the 7 and before ENTER.

To establish a scale factor (so that a number of pulses will be translated into a single spoken unit count), press:
5 ZZ 8 N ENTER

where N is the number of pulses corresponding to a single spoken unit count. For example, if a pulse from a flowmeter occurs for each 1/10 gallon of water flow, but the desired report is desired in thousands of gallons, a value of 10,000 would be used for N. The unit uses the word "percent" in speaking of the scale factor.

The spoken scaled value will "roll over" to zero upon reaching 4,294,967,294. Values above this should not be entered at the keyboard.

The default message for Totalizer channels is "Channel N totalizer count is N." User-recorded messages are normally done in two segments. Use program code 1 ZZ to record a preamble message such as "The total water flow reading is". Use program code 2 ZZ to record an ending units-of-measure message such as "thousand gallons". During the report, the unit will insert the digits comprising the actual scaled value. In this example, the resulting complete report would be "The total water flow reading is (spoken value) thousand gallons".

To establish a Totalizer alarm setpoint, press:
5 ZZ 6 N ENTER.

When the scaled value reaches N, the unit will go into Unacknowledged Alarm and begin dialing. You may program a value of zero for N, to cancel any previously programmed Totalizer alarm setpoint for channel ZZ.

To clear out all totalizer readings to zero in one step, press:
9 3 5 6 ENTER.

(5 ZZ 9, 935 2) ALARM CALL GROUPING

This is a programming step that "links" selected channels to selected dialout phone numbers, so that when a given channel goes into alarm, only the phone numbers "linked" to that channel will be dialed. Ordinarily, an alarm on any channel will cause dialing of the entire list of phone numbers.

Alarm Call Grouping is typically done when certain channels are associated with a specific category of personnel, such as electrical, plumbing, security, etc. Note, however, that Power Failure to the dialer causes dialing of all phone numbers. If you need to limit Power Failure alarm calls to selected numbers, turn off the regular Power Failure alarm function using code 9 2 1 0, described below, and then connect an unused input channel for power failure monitoring, using the contacts of a relay.

To program for Alarm Call Grouping, it is important to first write in your entire list of phone numbers on PROGRAMMING WORKSHEET A. Note that there is a 2-digit "Designation Number" on the worksheet associated with each phone number (01 for the first number, etc.). Note the correspondence with the 3-digit program code for entering phone numbers (701 for the first number, etc.).

Next, fill in PROGRAMMING WORKSHEET B, referring to the filled-in examples for guidance. The right-hand column will now contain the actual program code strings which you should now enter, terminating each string entry with the ENTER key.

For example, to link channel 1 to the second and fifth phone numbers, following the filled-in example, you would press:
5 01 9 02 05 ENTER

Phone numbers will always be dialed in ascending order of the 2-digit Designation Numbers, regardless of their order in your program code entry. Note that an alarm on any channel that is not "linked" with a program code entry will cause dialing of the entire list of phone numbers.

To read the linkage programming on channel ZZ, press:
5 ZZ 9 ENTER

To "un-link" channel ZZ so that it again calls all phone numbers, press:
5 ZZ 9 POINT ENTER

To undo all existing linkage on all channels, press:
9 3 5 2 ENTER

(6 ZZ, 902,920,921) ALARM TRIP DELAYS
The Alarm Trip Delay is the length of time after a violation occurs before the unit goes into Unacknowledged Alarm and begins dialing. The default value is 2 seconds for all inputs and 0.1 minute for power failure. During this time, if a status is read, the message will be the ALARM message, with the extra word 'alert' appended. If the violation is corrected before the Alarm Trip Delay times out, no alarm or dialout will occur.

There are two ways to change this Alarm Trip Delay: global (common for all channels except power failure) programming, and individual programming for each channel and power failure.

To program a new global Alarm Trip Delay, press:
9 0 2 V ENTER
where V is a value consisting of 1 to 4 digits, between .1 and 999.9 seconds. For example, possible entries include .1, 5, 5.1, and 600.1 (seconds).

If you wish to program a new individual Alarm Trip Delay for an individual ZZ channel, press:
6 ZZ V ENTER

To set a different Power Failure Trip Delay, press:
6 00 V ENTER (code 920 does the same thing)

To turn off the Power Failure Alarm function, press:
9 2 1 0 ENTER.

To turn the Power Failure Alarm function on again, press:
9 2 1 1 ENTER.

Note that the global code 902 overrides any previously set individual channel Alarm Trip Delays. Therefore, if you wish to establish a different global Alarm Delay and also program selected inputs for still different individual trip delays, perform the global programming first, and then any individual trip delay programming.

(7 DN, 901, 928) PHONE NUMBER PROGRAMMING
Also see ALARM CALL GROUPING, above, and Section 3.2.

NOTE: DN is the 2-digit Designation Number: 01 for the first phone number, 02 for the second number, up to 16 for the 16th phone number.

Refer to PROGRAMMING WORKSHEET A. Write down each phone number you wish to program, along with a person's name, for future reference.

To program the first phone number to be dialed on alarm, press:
7 01 (then the complete phone number) ENTER.

To program the second phone number to be dialed on alarm, use code 7 02 in place of 7 01, progressing to a maximum of code 7 16 for a 16th phone number.

Each phone number may be up to 24 digits in length. Be sure to include any necessary area codes or '1' prefixes.

To erase phone number DN, press:
7 DN POINT ENTER.

If you need Touch Tone dialing, press:
9 0 1 1 ENTER.

For extra-high-speed dialing, press:
9 0 1 2 ENTER.

CAUTION: High speed dialing is for specialized applications and may not work reliably with some telephone company exchanges.

To switch back to pulse dialing, press:
9 0 1 0 ENTER

To insert delays between dialed digits (e.g. after a leading '9' in PBX systems), in the programming process press the MINUS key once for each one-second delay desired. To extend the length of each delay beyond 1 second, press:
9 2 8 N ENTER
where N is the number of seconds of delay desired for each delay invoked with the MINUS key.

MISCELLANEOUS PROGRAMMING TIPS

(903) TIME BETWEEN ALARM CALL OUTS
This is the length of time after ending one alarm call out and before beginning the next call out. Default value is 2 minutes; range is 0.1 to 99.9 minutes. To program a different number of minutes V, press:
9 0 3 V ENTER.

(904, 922) ALARM RESET TIME
This is the length of time after acknowledgement before a given channel (or Power Failure) is automatically reset to a clear condition, ready to act on a new alarm condition. Refer to the diagram 'Anatomy of an Alarm' in SECTION 5 for a depiction of the various events involved in association with the Alarm Reset Time. Default value is 1 hour; range is 0.1 to 99.9 hours. To program a different number of hours V, press:
9 0 4 V ENTER.
To turn the Alarm Reset Timer function off, press:
9 2 2 0 ENTER.

CAUTION: YOU SHOULD NOT TURN THE ALARM RESET TIMER FUNCTION OFF under normal circumstances, because once a given channel's alarm has been

685 334

acknowledged, it would never again cause an alarm call out.

To turn the Alarm Reset Timer function on again, press:
9 2 2 1 ENTER.

(905) CLEAR ALL ACKNOWLEDGED ALARMS AND ALARM RESET TIMERS

Especially during setup and testing, it is useful to be able to retrip an alarm after it has previously been tripped and acknowledged, without having to wait for the Alarm Reset Time to expire. To perform this clear out, press:
9 0 5 ENTER.

At the panel, the same result may be more easily obtained by pressing DISARM/RE-ARM to disarm the unit, then pressing it again to rearm the unit.

(906) RING ANSWER DELAY

This is the number of rings required when calling the unit, before the unit will answer. A long ring delay might be programmed if you wish personnel to have the opportunity to answer a regular telephone on the same line, before the dialer would answer. Default value is 1 ring; range is 1 to 20 rings.
To program a different number of rings N, press:
9 0 6 N ENTER.

(907) NUMBER OF ALARM MESSAGE REPEATS

This is the total number of times each message or set of messages is spoken during each alarm call out. Normally a value of 3 repeats (strictly speaking, the alarm message plus 2 additional repeats) should be programmed, because some messages would not take long to speak and you need to allow adequate message recital time so that the person called will have adequate time to answer the phone call and hear at least one complete set of messages. Default value is 3 repeats; range is 1 to 20 repeats. To program a different number of repeats N, press:
9 0 7 N ENTER

(908) AUTOCALL TEST FUNCTION

The Autocall Test Function causes the unit to place test calls at regular intervals for the purpose of ongoing verification of dialer and phone line functioning. Calls are placed only once for each interval, to each regular phone number programmed (7 01 through 7 16), except that if anyone acknowledges a test call, no further calls will be placed for that time interval. Each call gives the station ID message and a statement that this is a test call, plus a report of all inputs.

To turn this function on, press:
9 0 8 1 ENTER

To turn it off, press:
9 0 8 0 ENTER.

The first series of calls begins as soon as the Autocall Test Function is turned on. Therefore, if you want the unit to call at 5 PM each day, you will need to turn this function on at that time. The default interval is 24 hours; range is 0.1 to 99.9 hours. To program a different interval V, press:
9 0 9 V ENTER.

(910) SECURITY ACCESS CODE

Once you establish a Security Access Code, unauthorized personnel are prevented from altering your programming or messages over the phone without first entering the Access Code. This does not affect programming access at the panel.

To establish an Access Code N of up to 8 digits, press:
9 1 0 N ENTER at the panel.

Once established, whenever you press a Command Tone 1 at the prompting beep, the unit first prompts you to enter the Access Code before allowing you to perform programming or message recording operations. You may still read existing programming without using the Access Code by pressing a Command Tone 2 at the prompting beep. However, the Access Code itself cannot be read over the phone.
To delete the Security Access Code so that no code required in order to perform over the phone programming, press:
9 1 0 POINT ENTER at the panel.

(921, 930) POWER FAILURE ALARM FUNCTION ON/OFF; DISARM/RE-ARM ALL ALARMS

To turn off the Power Failure Alarm function, press:
9 2 1 0 ENTER.

To turn the Power Failure Alarm function on again, press:
9 2 1 1 ENTER.

To disarm the unit, preventing any alarm call outs, press:
9 3 0 0 ENTER.

To rearm the unit, press:
9 3 0 1 ENTER.

At the front panel, the same result is more easily obtained by using the DISARM/RE-ARM key.

(700, 924) CALLBACK/CALL FORWARD

This feature causes the unit to dial a special 'zeroth' phone number on command. This is typically initiated over the phone, causing the unit to call back to the person who invoked the command, in order to verify the ability of the unit to successfully dial out. The unit gives a status report of all channels as part of this call.

To program this special callback number, press:
7 00 (then the complete phone number) ENTER

To initiate the actual dialing, press:
9 2 4 ENTER

If you have executed this command over the phone, the unit will advise you that it will be calling the callback number in 15 seconds. Then it will end the current call in preparation for placing the callback call. If you have executed this command at the front panel, the dialing will occur immediately.

(926) DELAY BEFORE RETURN TO NORMAL (EXIT DELAY)
Sometimes it is desirable to prepare the unit for the ability to detect violations and dial out, but with an 'exit delay' that allows the user time to exit or remove temporarily existing alarm violations before the unit becomes active. To do this, press:
9 2 6 V ENTER
where V is the desired delay in minutes (range 0.1 to 99.9 minutes). Then press DISARM/RE-ARM if necessary to extinguish the flashing DISARMED legend light. However, do not press NORMAL, but instead leave the unit in PROGRAM mode, with the PROGRAM light illuminated. The unit cannot go into alarm while in PROGRAM mode. When the delay period times out, the unit will automatically return to NORMAL mode and will then be ready to act on any alarm violations that occur after that time. This code must be re-entered each time you wish an exit delay, since the delay value automatically returns to the default value of 2 minutes upon timeout. The 2 minute default value provides protection against the possibility that someone might walk away leaving the unit in PROGRAM mode, or perhaps hang up the phone after performing over-the-phone programming without properly ending the call.

(932, 933, 934) MICROPHONE AND SPEAKER OPERATION
If you enable the front panel microphone using program code 933 as described below, the microphone will be automatically activated for a 15 second listening period at the end of each alarm or inquiry call, allowing you to hear the sounds near the unit from a remote telephone.

An additional prompting beep is issued at the end of this listening period, allowing you to postpone tone acknowledgement until after the listening period.

To turn this function on, press:
9 3 3 1 ENTER

To turn this function off, press:
9 3 3 0 ENTER

If you have turned the microphone on, as above, then during any phone call, you may also invoke a one-time listening period by entering Remote Program Mode (press 1 at the prompting beep) and then entering 9 3 2 # #.

To turn off the speaker so that neither alarm call or inquiry call activity is heard at the unit, press:
9 3 4 0 ENTER.

The speaker will still be heard when operating keys at the front panel.

To turn the speaker on again, press:
9 3 4 1 ENTER

The speaker volume may be adjusted via the trimpot shown on the Electrical Connection Diagram.

(935) PROGRAM CLEAR OUT OPERATIONS
The following list of program codes provides a flexible variety of operations to conveniently clear selected programming items in order to allow for a fresh start.

935 0	Clears out phone numbers; sets all delays to default.
935 1	Clears out phone numbers only.
935 2	Clears out all alarm call grouping linkage.
935 3	Sets all delays to default values.
935 4	Clears all user recorded messages.
935 5	Clears all programming except messages.
935 6	Clears all totalizer counts to zero.
935 9	Total clear out; ERASES ALL PROGRAMMING AND MESSAGES.

(940) DIAGNOSTIC READOUTS
To assist in analyzing the way the unit is operating, the following list of diagnostic count codes is provided.

940	Reads all 4 diagnostic counts (add 0 to clear all 4)
940 1	Reads Call In Count (add 0 to clear)
940 2	Reads Dial Out Count (add 0 to clear)
940 3	Reads Acknowledged Alarm Count (add 0 to clear)
940 4	Reads Power Failure Alarm Count (add 0 to clear)

685 / 396

SECTION 7. MAINTENANCE/TESTING/BATTERY REPLACEMENT

Regular testing is the main element of a maintenance program for ongoing autodialer reliability. The test should include interrupting AC power to the dialer for at least 4 hours to verify the gel cell battery maintains dialer operation for that time. You may wish to disconnect the phone cord to avoid nuisance calls during the test period.

The gel cell battery is much like a car battery in that at the end of its life when called on to deliver power, it discharges very quickly without having given any prior warning. The best protection is to replace the battery every 3 years regardless of any test results. The battery is a Power Sonic PS 640, 4 AH 6 volt. It may be ordered from RACO or from Power Sonic in Redwood City, CA, at (415) 364-5001.

SECTION 8. GLOSSARY OF TERMS USED IN THIS MANUAL

ACCESS CODE See Security Access Code.

ACKNOWLEDGEMENT The act of advising the dialer that its alarm message has been heard. This is done either by pressing a touch tone 9 at the prompting beep, or by calling the unit back after the alarm call has ended. Once acknowledged, further activity on that particular channel will not cause further dialing until the expiration of the Alarm Reset Time. See SECTION 5.1, 5.5.

ALARM CALL GROUPING Special programming established to cause specific input channels to cause dialing of only selected phone numbers. Used to provide separate alarm functions according to category of personnel, such as maintenance, security, plumbing, etc. See SECTION 6.1.

ALARM CONDITION For contact input channels, the Alarm Condition is the Open or Closed circuit condition opposite to that which was established as the Normal Condition for that channel. For example, for a channel programmed as Normally Open, the Alarm Condition would be Closed Circuit. Also see Violation. See SECTION 3.3, 5.3.

ALARM CRITERIA The chosen determination of what will constitute an alarm condition (violation) for a given channel. See Normally Closed.

ALARM RESET TIME The period of time, beginning at the moment an alarm is acknowledged, during which alarm dialing on behalf of that specific channel is suspended regardless of further activity of its input circuit. At the end of this period, the Acknowledged Alarm status is cleared for that channel. See SECTION 5.6, 6.

ALARM TRIP DELAY The time required for an input violation to remain in violation before the unit trips into the Unacknowledged Alarm state. See SECTION 6.

AUTOCALL A special test calling function. When Autocall is turned on, the unit places test calls at regular intervals to provide ongoing assurance of dialer and phone line operation. See SECTION 6.

AUTODIALER A device which constantly monitors a set of inputs from various external sensors, and places outgoing alarm calls when there is an alarm condition. It also allows inquiry calls.

AUTOEXTEND A unique feature on the VERBATIM autodialer which automatically extends the available message recording time as required, selecting the optimum speech memory rate for the user's voice message recording. See SECTION 4.2.

CALL BACK See Call Forward.

CALL FORWARD The unit may be commanded from the panel or over the phone, to place a call to a specific phone number. This is called Call Forwarding. If the number called is that of the person commanding the call from a remote telephone, then it is termed Call Back. This is typically done for test purposes. See SECTION 5.8, 6.

CALL OUT The action of the dialer placing calls to outside personnel or facilities.

CLOSED CIRCUIT CONDITION One of two possible states of a contact closure input circuit. Closed Circuit is the condition in which the contacts complete the electrical circuit connection. Open Circuit is the opposite condition, in which the contacts do not complete the electrical circuit connection. The Open Circuit condition is electrically equivalent to having no connection to the input circuit. A Closed Circuit input will measure zero volts DC from the input connection to the common connection point. An Open Circuit input will measure 5 volts DC. The Open or Closed Circuit status may also be read without a voltmeter, by use of Program Code 0 ZZ 0, where ZZ is the 2-digit channel number. See SECTION 3.3, 5.3.

COMMON The combined electrical return connection point for all contact closure inputs. One side of all contact inputs are connected to Common. Physically, this Common connection point is any of the 4 terminals marked C on terminal strip TS1. The circuit board internally connects Common to the AC ground (GREEN) terminal on terminal strip TS3. See SECTION 2.

DEFAULT Programming values which are built into the unit and remain in effect until the user alters them. Also, permanently available speech messages which are utilized when the user has not recorded his own messages.

DELAY BETWEEN DIGITS In some applications, an extra waiting time is needed between dialed digits. For example in some PBX systems, a 9 must be dialed, followed by a waiting time of several seconds before the main phone number may be dialed. See SECTION 3.2, 5.7, 6.

DESIGNATION NUMBER The two-digit "order number" of a phone number in the overall set of phone numbers programmed. For example, the designation number for the third phone number is 03. See Programming WORKSHEET A. See SECTION 3.2, 6.1, 6.2.

DIALER See Autodialer.

DRY Description of a sensor contact circuit that is not connected to any power source.

EXIT DELAY A delay period after a user arms the unit, before the unit will actually accept new alarms. Used to allow user to exit a protected entrance without tripping the unit into alarm. See SECTION 6.

GLOBAL Essentially "over all" or "universal". Programming that simultaneously sets the same value for all channels, but excluding the Power Failure Alarm function.

GROUPING See Alarm Call Grouping.

ID MESSAGE See Station ID Message.

INQUIRY CALL A call placed by personnel to the dialer. See SECTION 5.1.

LED A lighted legend indicator on the front panel.

LINK See Alarm Call Grouping.

MEMORY USE RATE See Speech Memory Rate.

NORMAL CONDITION For contact closure inputs, the Normal Condition is that condition (open or closed circuit) which normally exists. The opposite condition would create an alarm. See SECTION 3.3, 5.3.

NORMALLY CLOSED The designation for an input circuit where the sensing contacts are closed in the non-alarm state, and open to indicate an alarm condition. Also, programming of an input channel such that an Open Circuit state will cause an alarm. See also Closed Circuit Condition. See SECTION 3.3, 5.3.

NORMALLY OPEN See Normally Closed.

NON-VOLATILE MEMORY When AC power fails, the unit continues to operate for several hours on its internal Gel Cell battery. When this battery is near discharge, the unit automatically turns itself off. However all the user's programming and all user recorded messages are kept intact by Non-volatile Memory for up to ten years, so when power is later restored, no reprogramming or message recording will be required.

OPEN CIRCUIT CONDITION See Closed Circuit Condition.

POWER FAILURE The disappearance of 120 VAC power to the unit. The unit will continue to operate under power failure until its internal Gel Cell battery is discharged.

RECORDING RATE In the process of digitally recording the user's voice messages into speech memory, the message is recorded into memory at one of four possible rates. The faster this rate of memory usage, the higher the recording fidelity. However, this results in less total available recording time than at slower rates. Rate 1 is the fastest rate giving the best sound quality. The Autoextend feature automatically selects the optimum rate to allow adequate recording time for the user's own set of messages at the best possible sound fidelity. See SECTION 4.2, 4.3.

REPEATS The number of times a series of messages (including Station ID message) is spoken when an alarm call is placed. As used here, this number includes the first recital of the messages. For example, 3 repeats means 3 times total, not 4. See SECTION 5.3, 6.

RING ANSWER DELAY The number of rings required before the dialer will answer an inquiry call. See SECTION 5.3, 6.

RUN TIME METER A feature which, when turned on, accumulates the total number of hours that an input channel is in the Closed Circuit condition. Typically used to monitor equipment operation time, particularly alternating pump systems. See SECTION 3.3, 6.

SCALE FACTOR A translation factor which may optionally be entered in conjunction with the Pulse Totalizer function. The spoken totalizer reading will be the actual number of pulses accumulated, divided the programmed scale factor. See SECTION 6.X.

SECURITY ACCESS CODE A code optionally programmed by the user at the front panel. Once programmed, this code is required in order to perform any program operations over the phone. See SECTION 5.7, 6.

SPEECH MEMORY RATE See Recording Rate.

STATION ID MESSAGE A message which is always included in all phone calls to or from the unit, intended to identify the unit. The default Station ID Message is "ID number is 1". See SECTION 4.1, 4.3.

TIME BETWEEN ALARM CALLS. With the unit in Unacknowledged Alarm status, the waiting time from the time the unit terminates a given alarm call, until the time when the unit again accesses the phone line to place the next call. During this interval (default 2 minutes), personnel may call the unit back, which will acknowledge the alarm and suspend further calling. See SECTION 5.4, 6.

VIOLATION For contact closure inputs, a violation (also called Alarm Condition) is the Open or Closed Circuit condition which is opposite the condition which has been programmed as Normal for that channel. For example, if a given input channel is programmed for Normally Open operation, then a Closed Circuit is a violation for that input. If the violation persists for the Alarm Trip Delay time, the unit will go into Unacknowledged Alarm state and begin placing alarm calls. See SECTION 3.3, 5.3, 5.6.

685 400

SECTION 9. TROUBLESHOOTING TIPS

UNIT IS DEAD; NO LIGHTS OR VOICE.
If the unit will not respond to the ON/OFF key, verify that the battery is connected. Verify that there is 120 volts AC between the WHITE and BLACK wire terminals on TS3. Verify that the fuse (1/4 amp slow blow) is not blown.

UNIT SEEMS OK BUT WILL NEITHER ANSWER NOR DIAL OUT ON PHONE LINE.
This assumes that you hear a voice report at the panel when you press CHECK STATUS. With the NORMAL light lit, test the phone line by pressing DIALOUT. The PHONING light should light and you should hear a dial tone.

If you do not hear a dial tone, open the door of the unit and verify that relay K1 is correctly seated in its socket, with its indentation mark facing downward. Check the phone line and its connection with a DC voltmeter and/or a separate telephone handset. Verify the presence of about 50 volts DC between the RED and GREEN conductors on phone line terminal strip TS2. This voltage will drop to just a few volts when the dialer or other connected phone device goes off hook (PHONING light lit).

If you do hear the dial tone after pressing DIALOUT, press the digits of a valid phone number. You should hear the loud clicks of relay K1 (for pulse dialing) or else the tones of tone dialing, as you press each digit. The dial tone should cease after you have entered the first digit. Continue until you have dialed the complete phone number. You should now hear the sound of ringing and someone answering at the other end. End the call by pressing NORMAL.

UNIT ANSWERS INCOMING CALLS, AND ALSO GOES INTO ALARM WHEN IT SHOULD AND ATTEMPTS TO DIAL OUT, BUT DOES NOT REACH DIALED NUMBER.
First, verify whether the unit is actually attempting to dial out, as evidenced by the clicks or tones of dialing followed by message recital. If not, then see the separate problem below, 'unit does not go into alarm when it should'.

If in the above procedure you do hear the clicks or tones of dialing, but the dial tone does not cease, perhaps your phone system requires the opposite mode of dialing (pulse vs tone) from its presently set mode. Read the present mode by pressing PROGRAM 9 0 1 ENTER. Then set the opposite by entering 9 0 1 1 (to change to tone dialing), or 9 0 1 0 (to change to pulse dialing). Then press NORMAL and then repeat the manual DIALOUT procedure as described above.

Verify that you have programmed complete phone numbers including any area codes or "1" prefixes that might be required to complete the call.

Consider whether your phone system requires a prefix such as 9 to be dialed, followed by a delay period (to access an outside phone line) before dialing out. If so, see SECTION 3.2.

UNIT DIALS OUT BUT WILL NOT ANSWER INCOMING CALLS.
Check programmed ring delay by pressing PROGRAM 9 0 6 ENTER. If it is set for a number larger than one, the dialer is not supposed to answer until the corresponding number of rings has been received. Try setting it back to 1 using code 9 0 6 1 ENTER. If the unit still will not answer incoming calls but is able to dial out, try plugging a regular telephone into the same phone jack in place of the dialer and see if it rings. If the problem is not the phone line, try temporarily connecting test point C to test point D on the main circuit board, for a period of about 5 seconds and see if it 'answers' with the PHONING light and a voice report, then call the factory for advice.

UNIT WILL NOT GO INTO ALARM WHEN IT SHOULD.
This is usually the result of incomplete understanding of how the dialer manages alarms.

For the dialer to go into Unacknowledged Alarm and Dial Out, a violation must be continuously present for the Alarm Trip Delay time. At least one phone number must be programmed. The unit must not be in the DISARMED state. And, the channel that has the violation must not already be in an acknowledged alarm state, since acknowledged alarm status for a given channel (including power failure) precludes further activity on that channel until that status is cleared. Refer to SECTION 5 for a discussion of how the unit manages alarms.

To clear the acknowledged alarm status of all channels including power failure, starting with the NORMAL light lit, press DISARM/RE-ARM to get the flashing DISARMED indication, then press it again to re-arm the unit with all acknowledged alarm statuses cleared. Now any violations lasting longer than the Alarm Trip Delay will cause unacknowledged alarms and dialing.

Unacknowledged alarm status is indicated by the corresponding channel number flashing. Acknowledged alarm status is indicated by the same light remaining on continuously without flashing.

If you don't observe this, press PROGRAM and then press 7 0 1 ENTER to check your first phone number. Press 9 0 2 to check the Global (overall) Alarm Trip Delay. For the specific channel ZZ (2 digits) that you are attempting to create an alarm on, also press 6 ZZ to check for any longer Individual Alarm Trip Delay setting.

Check the Normally Open/Normally Closed alarm criteria programming for this channel by pressing 5 ZZ. Make sure it is not set for No Alarm or for Run Time Meter, since these settings would not allow an alarm. Now, for example, if the channel is configured Normally Open, you will want to temporarily provide a closed circuit at its input to trip the alarm. You can directly read and verify the Open/Closed status you are applying by pressing 0 ZZ 0. You may also use a DC voltmeter to trace your circuit connections. With the dialer turned on, an open circuit to a channel contact input reads 5 volts DC with respect to the "C" terminals or electrical ground. A closed circuit reads zero volts.

UNIT KEEPS CALLING WHEN IT SHOULD NOT

Be sure that the initial alarm call is in fact being acknowledged. The unit will specifically state "alarm is acknowledged" at the moment you successfully acknowledge the call. The unit will accept a tone acknowledge only following the prompting warble beep.

Also, be sure that the alarm violation has been corrected. Otherwise, even if the alarm is acknowledged, when the Alarm Reset period times out, dialing will begin again.

Write down exactly what the unit recites when it gives the unwanted call. This provides valuable guidance as to the cause and correction of the problem. You may need to lengthen the Alarm Trip Delay in order to minimize nuisance alarms, particularly the power failure Alarm Trip Delay (code 920). If you hear an alarm message with the phrase "now normal" added at the end, it means that the violation occurred long enough to trip the alarm but has returned to normal by the time you are hearing the report. In the case of power failure, if the power has been restored by the time the message is being heard, the message will be "Power is on". The fact that power is mentioned at all lets you know that there has been a power failure lasting longer than the power failure Alarm Trip Delay. Power will continue to be mentioned in any phone call or front panel status check, until the Alarm Reset time expires.

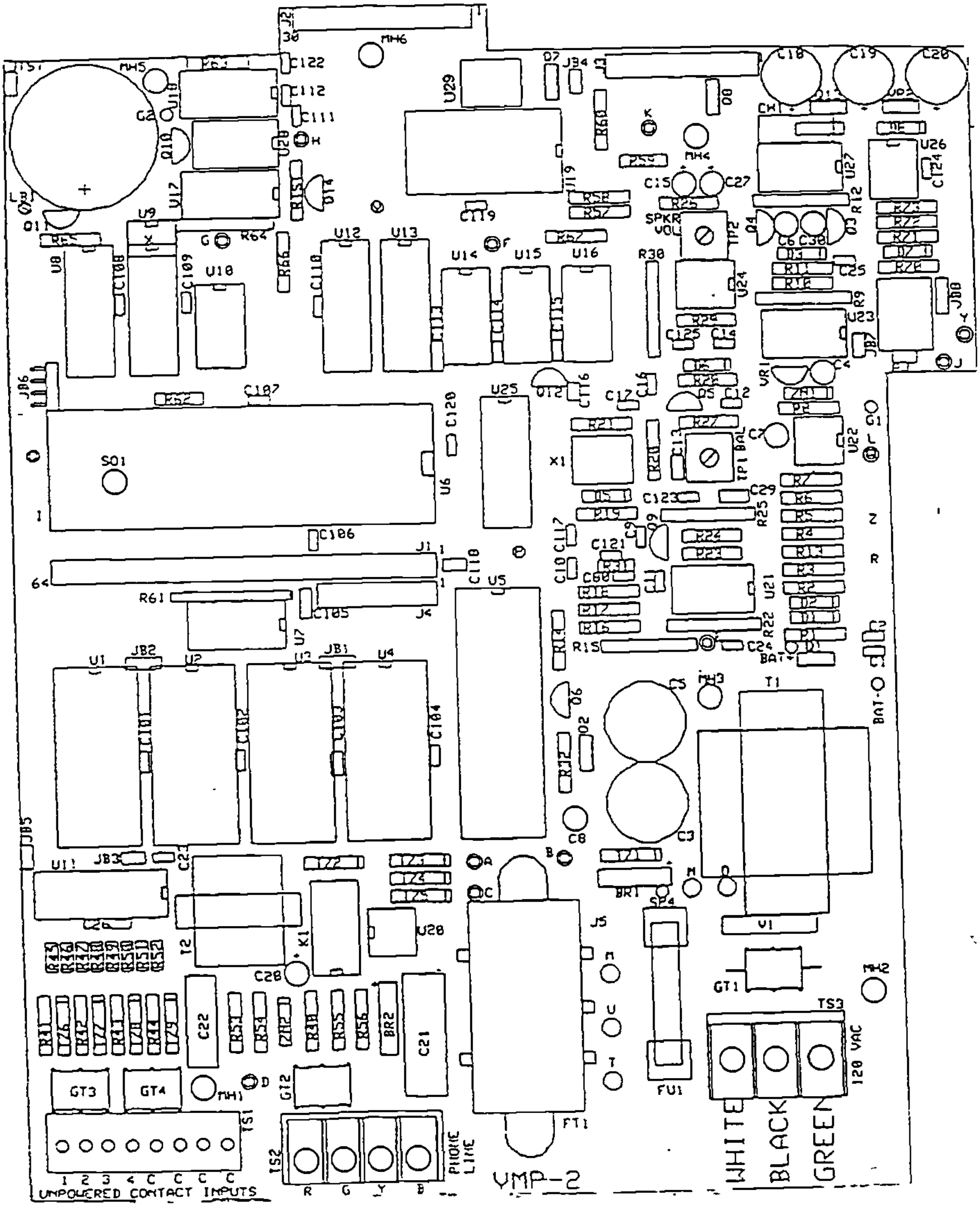
UNIT IS CONTINUOUSLY "LOCKED" IN ONE STATE, OR IS BEHAVING ERRATICALLY

Erroneous programming or other factors may have caused program lockup. With the unit turn on, use a screwdriver blade to momentarily connect the two pins on Jumper Block JB5 (see Electrical Connection Diagram).

If this does not return the unit to normal operation, next try jumping the 2 pins on JB3. This latter step will erase all user programming and recorded messages, so all user programming and messages will need to be re-entered.

685 402

COMPONENT LAYOUT DIAGRAM



FCC NOTICE TO USERS

1. You must notify your telephone utility as follows:

   a. Intention to install an FCC Part 68-registered device.
   b. The FCC registration number: HKS-23J06304-AL-R
   c. The ringer equivalence number: 0.3A
   d. When the device is disconnected from the telco network and will not be reconnected.

2. These units may not be used on party lines.

3. The telco has the right to make changes in their network which may affect the operation of your unit, provided adequate notice is given to you in advance to permit continued correct operation.

4. In the event of operational problems, disconnect your unit by removing the modular plug from the modular telephone jack. To test the phone line, temporarily plug a working rotary-dial telephone into the jack normally used by the VERBATIM. If the substitute telephone works correctly, your VERBATIM has a problem and should be returned for repairs (in or out of warranty). If the substitute telephone does not work correctly, notify the telco that they have a problem and request prompt repair service (at no cost to the user).

5. The user may not under any circumstances (in or out of warranty) attempt any service or repairs on the VERBATIM. It must be returned to RACO for all repairs.

685 404

INDEX

685 406

PROGRAMMING WORKSHEET A

PART 1: PHONE NUMBER PROGRAMMING

2-DIGIT PHONE NUMBER DESIGNATION	USE PROGRAM CODE	PHONE NUMBER (Including any necessary prefixes or area codes)	PERSON
01 (First)	701		
02 (Second)	702		
03 (Third)	703		
04 (Fourth)	704		
05 (Fifth)	705		
06 (Sixth)	706		
07 (Seventh)	707		
08 (Eighth)	708		
09 (Ninth)	709		
10 (Tenth)	710		
11 (Eleventh)	711		
12 (Twelfth)	712		
13 (Thirteenth)	713		
14 (Fourteenth)	714		
15 (Fifteenth)	715		
16 (Sixteenth)	716		

PART 2: RECORD OF ANY OPTIONAL PROGRAMMING TO ALTER SELECTED PARAMETERS FROM THEIR NORMAL DEFAULT VALUES

PROGRAM CODE	PARAMETER DESCRIPTION	DEFAULT VALUE	WRITE IN ANY ALTERED VALUES YOU PROGRAM

EXAMPLE:

902	Alarm Trip Delay	2 seconds	40 seconds

WORKSHEET B: ALARM CALL GROUPING PROGRAMMING

Used to "link" certain input chanels to call only selected phone numbers.

PART 1: As an organizational step, write in a Group Description Name (Electrical, Security, etc.) for each of your phone number groups, and the two-digit designation number of the phone numbers you want included in each group. Refer to the filled-in example below. This should be done only after you have already entered your entire list of up to 16 phone numbers on WORKSHEET A.

GROUP DESCRIPTION (Electrical, etc.)	2-DIGIT PHONE # DESIGNATION (taken from WORKSHEET A)

EXAMPLE:

GROUP DESIGNATION (Electrical, etc.)	2-DIGIT PHONE # DESIGNATION (taken from WORKSHEET A)
Maintenance	01, 04, 05, 06
Electrical	03, 04
Security	02, 05

PART 2: For each input channel that you wish to have "linked" to one of your groups, write in your chosen Group Description Name (Electrical, etc.), and the corresponding set of 2-digit Phone Number Designations which you established above. Finally, write in these same sets of 2-digit codes, without the separating commas, to the right of the printed program code (501, etc.). This establishes the complete program code to enter for each channel that you want "linked" to call only a selected group of phone numbers.

Note that any channels that you do not enter such a program code for, will cause dialing of the entire list of phone numbers, when that channel goes into alarm.

CHAN	LINKED TO GROUP	CORRESP. PHONE # DESIG'S EST. ABOVE	PROGRAM CODE TO ENTER
01			501 9
02			502 9
03			503 9
04			504 9
05			505 9
06			506 9
07			507 9
08			508 9
09			509 9
10			510 9
11			511 9
12			512 9
13			513 9
14			514 9
15			515 9
16			516 9
17			517 9
18			518 9
19			519 9
20			520 9
21			521 9
22			522 9
23			523 9
24			524 9
25			525 9
26			526 9
27			527 9
28			528 9
29			529 9
30			530 9
31			531 9
32			532 9

EXAMPLE, FOLLOWING PART 1 EXAMPLE ABOVE:

CHAN	LINKED TO GROUP	CORRESP. PHONE # DESIG'S EST. ABOVE	PROGRAM CODE TO ENTER
01	Security	02, 05	501 9 02 05
02	Security	02, 05	502 9 02 05
03	Electrical	03, 04	503 9 03 04
04	Maintenance	01, 04, 05, 06	504 9 01 04 05 06
05	—	—	~~505 9~~
06	Electrical	03, 04	506 9 03 04
07	—	—	~~507 9~~
08	—	—	~~508 9~~
09			509 9
10			510 9
11			511 9
12			512 9
13			513 9
14			514 9
15			515 9
16			516 9
17			517 9
18			518 9
19			519 9
20			520 9
21			521 9
22			522 9
23			523 9
24			524 9
25			525 9
26			526 9
27			527 9
28			528 9
29			529 9
30			530 9
31			531 9
32			532 9

The above filled-in example is for an 8-channel unit. Three groups were established, and 5 of the channels were linked to a group. The remaining 3 channels were not linked to any group, and therefore, those 3 "unlinked" channels would dial the entire list of phone numbers in regular order.

685 408

WORKSHEET C: MESSAGE PLANNING AND RECORDING

MESSAGE DESIGNATION	PROGRAM CODE	MESSAGE CONTENT	APPROX. LENGTH
Station ID	1 0 0		
Ch 01 Alarm	1 0 1		
Ch 01 Normal	2 0 1		
Ch 02 Alarm	1 0 2		
Ch 02 Normal	2 0 2		
Ch 03 Alarm	1 0 3		
Ch 03 Normal	2 0 3		
Ch 04 Alarm	1 0 4		
Ch 04 Normal	2 0 4		
Ch 05 Alarm	1 0 5		
Ch 05 Normal	2 0 5		
Ch 06 Alarm	1 0 6		
Ch 06 Normal	2 0 6		
Ch 07 Alarm	1 0 7		
Ch 07 Normal	2 0 7		
Ch 08 Alarm	1 0 8		
Ch 08 Normal	2 0 8		
Ch 09 Alarm	1 0 9		
Ch 09 Normal	2 0 9		
Ch 10 Alarm	1 1 0		
Ch 10 Normal	2 1 0		
Ch 11 Alarm	1 1 1		
Ch 11 Normal	2 1 1		
Ch 12 Alarm	1 1 2		
Ch 12 Normal	2 1 2		
Ch 13 Alarm	1 1 3		
Ch 13 Normal	2 1 3		
Ch 14 Alarm	1 1 4		
Ch 14 Normal	2 1 4		
Ch 15 Alarm	1 1 5		
Ch 15 Normal	2 1 5		
Ch 16 Alarm	1 1 6		
Ch 16 Normal	2 1 6		
Ch 17 Alarm	1 1 7		
Ch 17 Normal	2 1 7		
Ch 18 Alarm	1 1 8		
Ch 18 Normal	2 1 8		
Ch 19 Alarm	1 1 9		
Ch 19 Normal	2 1 9		
Ch 20 Alarm	1 2 0		
Ch 20 Normal	2 2 0		
Ch 21 Alarm	1 2 1		
Ch 21 Normal	2 2 1		
Ch 22 Alarm	1 2 2		
Ch 22 Normal	2 2 2		
Ch 23 Alarm	1 2 3		
Ch 23 Normal	2 2 3		
Ch 24 Alarm	1 2 4		
Ch 24 Normal	2 2 4		
Ch 25 Alarm	1 2 5		
Ch 25 Normal	2 2 5		
Ch 26 Alarm	1 2 6		
Ch 26 Normal	2 2 6		
Ch 27 Alarm	1 2 7		
Ch 27 Normal	2 2 7		
Ch 28 Alarm	1 2 8		
Ch 28 Normal	2 2 8		
Ch 29 Alarm	1 2 9		
Ch 29 Normal	1 2 9		
Ch 30 Alarm	1 3 0		
Ch 30 Normal	2 3 0		
Ch 31 Alarm	1 3 1		
Ch 31 Normal	2 3 1		
Ch 32 Alarm	1 3 2		
Ch 32 Normal	2 3 2		
		Total estimated recorded message length in seconds------->	

Addendum to Verbatim Owner's Manual

Changes in Verbatim Firmware
Revision 2.12

Raco Manufacturing and Engineering continually makes improvements in the operation and functionality of its products. This addendum describes Verbatim firmware revision 2.12 and its differences to the previous firmware revisions.

Are You Familiar with the Operation of the Verbatim Autodialer Yet?

Changes to a few, very specific features of the Verbatim are described in this addendum. It is assumed that the reader of this addendum is already familiar with the basic operation and programming method of the Verbatim. If this is not the case, please take the time necessary to familiarize yourself with the Verbatim autodialer by reading the Verbatim Owner's Manual.

Addendum Table of Contents

App. 1 Use New Programming Code for Total Clear-down

Section 3.1 of the Verbatim User's Manual (Starting Up and Clearing the Unit) advises that it's a good procedure to completely clear down the unit back to factory defaults. This step clears out all programming and should be performed prior to installation and before programming the unit for the application.

The User's Manual says to use programming code 9359 for the total clear-down operation. In firmware revision 2.12 programming code 9359 still operates identically to the way it did in previous firmware revisions. However, a new programming code, 935911, performs a more thorough clear-down, including a hardware reset.

For total clear-down press:

9 3 5 9 1 1 ENTER

This operation will perform a special type of hardware reset which clears all memory including user speech messages and resets all user programming back to factory defaults.

Note. If you perform this operation while programming the Verbatim over-the-phone the unit will hang up the phone without even saying "good-bye". However, the Verbatim will be ready to receive another a call from you immediately.

App. 2 Modbus Protocol & Local Data Logger (LDL) Now User Settable

In previous Verbatim firmware revisions, network protocols were always "hardcoded" at the factory and could not be altered. With firmware revision 2.12 and above the user may reconfigure networks and protocols as desired (within the basic capabilities of the unit as specified at time of purchase).

In fact, units are now shipped with *NO* protocols enabled. The user ***must*** enable the desired protocol at the time of installation according to the intended application of the product.

App. 2.1 Determining Network Port Number & Protocol Identifier

The Verbatim supports four device ports, named NET1-4. Connections to any of these ports are completely separate from each other. Each will need to be configured independently. The table below describes how they may be used. NET3, usable only for the Modbus Plus protocol, is only available in the Verbatim Gateway product. Consult the factory for details.

Port Name	NET1	NET2	NET4
Location:	J307 on expansion card (diagram in chapter 2)	J303 on expansion card (diagram in chapter 2)	inside door front panel card (see section 2.3)
Connector Type:	RJ-45	RJ-45	VPPC-1
Interface Specification:	RS-232C	RS-232C	Centronics
Supported Protocols:	Modbus, LDL	Modbus, LDL	LDL only

Network Device Ports

The general steps for connecting the Verbatim to a Modbus network or to a Local Data Logger printer are as follows:

- Determine which network interfaces are needed for the application This step is beyond the scope of this manual. Consult the equipment vendors, or contact RACO Customer Service for advice

- Prepare the external network connection. The following subsections describe usage and configuration for many interfacing devices. Follow the vendor's procedures for installation and configuration.

- Connect the correct cable between the autodialer and the network. Section 2 provides a diagram. Appendix F contains wiring diagrams for all cables. It now ought to be safe to power up all equipment.

- Use code 4906 to configure the desired protocol driver on the autodialer port.

- Use the other 490 codes to alter default settings for the autodialer's baud rate, data bits, stop bits, parity, node number, and communications timers as appropriate. If necessary, use the 495 codes to further optimize performance.

App. 2.1.1 User Codes for Enabling a Protocol on a Port

To enable a protocol on a particular port enter:

4906 net * N

Function: Sets protocol for network.
Omit *N to just read the value

Range: See Table below

Default: NONE. All protocols must be explicitly configured by the user.

Response: *<net ID> protocol is <current protocol>*

N	Protocol	Description	Nets
0	NONE	device disabled	All nets
5	MODBUSM	Modbus Master	Net 1 or Net 2 on VCP card
128	LDL	Local Data Logging May only be used on one device	Net 2 only on VCP Otherwise - Net 4

Protocol Identifiers

If there is any error setting a protocol then the error response is made, and the prior protocol and operations are restored. If the configuration is successful the following things happen:

- All network parameters are set to their default values, and all diagnostics are cleared. These default values depend on the protocol.

- If the new protocol is different than the old, all RCs using that device are completely cleared down. If the old and new protocols are identical, then only the diagnostic information is cleared.

- If the new protocol is Modbus, RC scanning on the net is enabled.

- If the new protocol is LDL then the prior LDL device (if any) is closed and output will resume on the new device with no data loss.

- If the old protocol is LDL and the new one is not, then all unprinted data will be lost.

App. 2.2 Local Data Logger Specifics

The Local Data Logger (LDL) interface (either serial or parallel) may now be turned ON/OFF or reconfigured by the operator. If your LDL printer is interfaced via the Asynchronous Communications option (VCP Card), you may now set serial interface parameters to match the settings of your serial printer. The serial parameters of baud rate, data bits, stop bits and parity may be read and changed by programming codes.

NOTE: The Local Data Logger now must be turned ON by the operator before any LDL output will be sent to the printer. LDL is set to OFF by factory default.

App. 2.2.1 Determining Your Local Data Logger Method of Interface

There are two possible ways to interface a printer to the Verbatim for Local Data Logging — parallel or serial. The remainder of this section describes these two methods and the steps necessary to connect and configure LDL.

Parallel interfaced printers are the most common type of printers and are usually the least expensive. Raco Verbatim autodialers always include a parallel interface for Local Data Logging at no extra cost. However, there is one disadvantage of parallel interfaced printers. The parallel interface requires that the cable between the Verbatim and the printer be short — about 15 feet maximum.

Serial interfaced printers can have comparatively long cables — up to several thousand feet if the baud rate is derated with the increase in cable length. The major disadvantage of serial printers is that the serial interface usually increases the cost of the printer

Is Serial Local Data Logging a Possibility?

Your Verbatim autodialer may have been configured at the factory with the Verbatim Asynchronous Communications Option. This Verbatim expansion card is sometime also called the Async. Com. Card and is label on the expansion circuit card as VCP.

You may not have specifically requested this option. However, you may have received it as a result of ordering the Modbus PLC interface option. If your Verbatim unit *does* have the Async. Com. Card then it is possible to interface a serial printer for Local Data Logging. That is, if you are using the Async. Com. Card for just one Modbus (PLC) network connection then you may use the remaining network port to interface a serial printer for Local Data Logging.

Required Cables

Serial printers are interfaced via Raco cable VSER-01 (cable drawing is Owner's Manual Appendix G-2) connected to the modular jack J303 on the VCP card. (Refer to Owner's Manual Appendix F-4)

The parallel interface for Local Data Logging uses Raco cable VPPC-1 (cable drawing is Appendix G-3) connected as per the instructions in section 2.3 of the Verbatim Owner's Manual.

App. 2.2.2 Turning ON LDL

To turn ON the Local Data Logger interface press·

4 9 0 6 Net * 128 enter

Where Net is:

2 for the Serial Interfaced LDL (Modular Connector J303 on VCP Card)
4 for the Parallel Interfaced LDL (Dual-row Connector on Front Door)

Note: * is the key labeled 'POINT' on the top portion of the key and '*' on the lower portion..

App 2.3 Setting Serial LDL Parameters

Note: The following is not applicable to parallel interfaced LDL.

To read the serial communication parameters for serial interfaced LDL press:

4 9 0 0 2 enter

To reset all serial communications parameters for serial LDL to factory defaults press:

4 9 0 0 2 * enter

To set the baud rate for serial interfaced LDL press:

4 9 0 1 2 * N enter

Where N, if present, is 50, 75, 110, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, 9600, 14400, 19200, 28800, or 57600. All other values are ignored.

To set the data bits for serial interfaced LDL press:

4 9 0 2 2 * N enter

Where N, if present, is 5, 6, 7 or 8. All other values will be ignored.

To set the stop bits for serial interfaced LDL press:

4 9 0 3 2 * N enter

Where N, if present, is 0 for NO parity, 1 for ODD parity, 2 for EVEN parity, 3 for SPACE parity, or 4 for MARK parity. All other values will be ignored.

App 2.4 LDL Notes and Exceptions

NOTES:

1) Factory defaults for serial interfaced LDL are: 9600 baud, 8 data bits, 1 stop bit, NO parity.
2) Setting serial communications parameters applies only to printers interfaced via the Asynchronous Communications Option (NET 2). When a Local Data Logger printer is interfaced via the parallel printer interface (NET 4) there are no communications parameters to be set.
3) Only one interface method, either serial or parallel, may be used at a time. Turning ON the serial interfaced LDL turns OFF the parallel interfaced LDL and vise versa.

App. 3 Programming Code 917 Removed But Features Still Exist

The combined programming code for *Phone Fault Detection & Automatic Tone/Pulse Selection* has been removed.

App. 3.1 Automatic Tone/Pulse Selection

Automatic tone/pulse selection can no longer be configured by the operator. However, the Verbatim still performs automatic selection of tone or pulse dialing.

The unit performs automatic tone/pulse selection only after the following events occur:
1) power is applied to the unit *and* dialing mode had not been altered from default tone mode.
2) the operator performs programming code 9 3 5 9 1 1 to set all programming to factory defaults.
3) jumper blocks JB-3 or JB-5 shorted together for hardware reset.

Notes:
1) performing programming codes 9 3 5 9 or 9 3 5 9 1 1 or shorting jumper block JB-3 will erase all programming.
2) If the operator has explicitly programmed the dialing mode (using code 901) cycling power or shorting jumper block JB-5 will ***not*** change the dialing mode programming.

If the Verbatim has automatically selected the dialing mode the resulting setting may be read by using programming code 901. And, as in all versions of Verbatim firmware, the operator may also use code 901 to manually select tone or pulse dialing mode. Refer to the Verbatim Owner's Manual section 3.2

App. 3.2 Phone Fault Detection

Use programming code 916 to turn ON/OFF Phone Fault Detection. In prior firmware revisions programming code 916 was only used to set the Phone Fault Detection Interval. Now, also use code 916 to turn ON/OFF the Phone Fault Detection feature as follows:

Turn Phone Fault Detection OFF by setting the Phone Fault Detection Interval to a value of 0.
Turn Phone Fault Detection ON by setting any valid Phone Fault Detection Interval.

To turn OFF Phone Fault Detection press:

9 1 6 0 enter

To turn ON Phone Fault Detection press:

9 1 6 V enter

Where: V a valid Phone Fault Detection interval of 0.1 hours to 24.0 hours.

App. 4 Personal Identification Numbers

The personal identification number (PIN) feature is provided as a way both to limit telephone access to the Verbatim autodialer and to provide an audit trail of acknowledgments. The use of PINs is always optional, and the default configuration omits them. PINs do not alter operations of the programming mode security feature (code 910) in any way.

Each authorized operator is assigned a unique PIN to identify them. This PIN will appear in the printed Local Data Logger reports of telephone sessions and alarm acknowledgments. The remainder of this section describes operations in more detail.

App. 4.1 PIN Operations

A PIN consists of 1-5 digits. It is not possible to use any letters or other symbols Up to 32 distinct PINs may be configured.

Once any PIN has been configured, thereafter all over-the-phone sessions will require entry of a valid PIN. The session begins with the station ID message followed by a prompt to enter a PIN The entry is made by pressing the DTMF keys, followed by the double pound-key termination.

This prompt is given a maximum of three times at 10 second intervals. If no valid PIN is entered, the Verbatim says *good-bye* and then hangs up. The calling sequence then proceeds as if the call had not been answered at all.

If a valid PIN is entered, that event is logged and the session continues as standard. Entry of the PIN does not automatically acknowledge anything. Use of the usual DTMF tones is still required. Any acknowledgments during the session will cause that operator's PIN to become associated with the acknowledgment status of the channel. That PIN will then be printed as part of any subsequent LDL status reports. Voice status reports omit this PIN information.

Only the most recent PIN to have acknowledged a channel (either ALARM or RTN) will be logged. Any operator working from the front panel is always given the PIN of 00000. Standard operations may be restored at any time by clearing all PINs (code 48*).

App. 4.1.1 PIN Local Data Logger Output Examples

The following text provides a sample of the LDL output when PINs are active. All PIN-specific entries are shown in boldface italics. The first segment shows a sample alarm session:

```
ALARM  MODE 13:39:10 Mon.  8/14/95

Alarm session with phone #1. # is 1.   13:39:16 Mon.  8/14/95

Valid PIN 50000 entered 13:39:39 Mon.  8/14/95

Channel                         Status

-----------------------------------------------------

   1                           ALARM

   2                           ALARM

   3                           ALARM

Acknowledgment for linked alarms via phone #1 (1) PIN was 50000.
13:39:46 Mon.  8/14/95

HUNG-UP at  13:39:47 Mon.  8/14/95

NORMAL MODE  at 13:39:47 Mon.  8/14/95
```

This next segment shows a sample phone-in session. Note that the PIN '00000' indicates operator acknowledgment from the front panel.

```
CALL-IN MODE 13:41:52 Mon.  8/14/95
```

```
Valid PIN 50000 entered 13:42:02 Mon.  8/14/95

Channel                              Status
-------------------------------------------------------
   1                               ALARM, Acknowledged by PIN 50000
   2                               ALARM, Acknowledged by PIN 00000
   3                               ALARM, Acknowledged by PIN 40032
   4                               NORMAL

HUNG-UP at  13:42:19 Mon.  8/14/95
```

App. 4.2 Programming Personal Identification Numbers

The following programming codes are provided for configuring and controlling the PIN functionality. For security reasons, all commands in this group are available only from the front panel. If entered over the telephone, the *error, enter program code* response is made.

48 ddddd
Function — Establishes 'ddddd' as a valid PIN.
'ddddd' must consist of 1 to 5 numeric digits.
Response — *P-I-N is ddddd* (success)
P-I-N exceeded (32 PINs already configured, invalid characters, too long, or '00000' is specified.
Note — The sequence '00000' is reserved to indicate any front panel operator.

48 ddddd *
Function — Deletes 'ddddd' as a valid PIN.
Response — *P-I-N ddddd is cleared* (success)
P-I-N error (failure)
Note — Any channels currently acknowledged by PIN 'ddddd' will thereafter appear acknowledged "by PIN 00000".

48
Function — Lists all PINs currently configured
Response — *All P-I-Ns programmed are ...list...* (PINs currently configured)
No P-I-N is programmed (No PINs currently configured)

48 *
Function — Erases all PINs currently configured
Response — *All P-I-Ns programmed are cleared*

Note: This effectively turns off all PIN functionality. No more "acknowledged by PIN ....." messages will be logged.

App. 5 Totalizer Alarm Reset Timers Now Affected by Programming Codes 904 and 922

In prior firmware revisions changing the setting of either code 904 (Read/Set Alarm Reset Time) or code 922 (Alarm Reset Timer On/Off) had no effect on the alarm reset timers for totalizer alarm channels. Now, with Version 2.11, changing the setting of code 904 or 922 will clear the alarm reset timers for totalizer channels in exactly the same manner as for discrete and analog alarm channels.

App. 6 Feature Codes 923 and 981 Now Mutually Exclusive

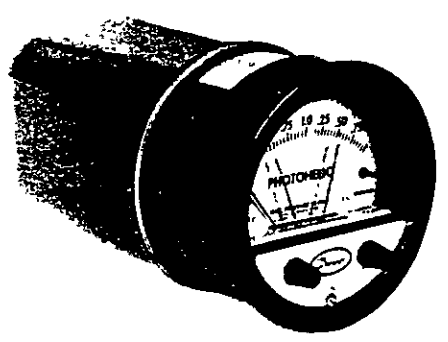
Programming code 923 is used to program the Verbatim to cease the alarm calling sequence when all inputs have returned-to-normal status. Programming code 981 is used to program the Verbatim to make calls to personnel when the inputs to channels with acknowledged status return-to-normal (no violation) These two features have now been made mutually exclusive. That is, setting one feature ON sets the other OFF. Refer to page K-5 for details on code 923. Refer to section E.1 for details on code 981.

Dwyer

SERIES A3000 PHOTOHELIC® DIFFERENTIAL PRESSURE SWITCH/GAGE

685 418

Sp cifications – Installation and Operating Instructions



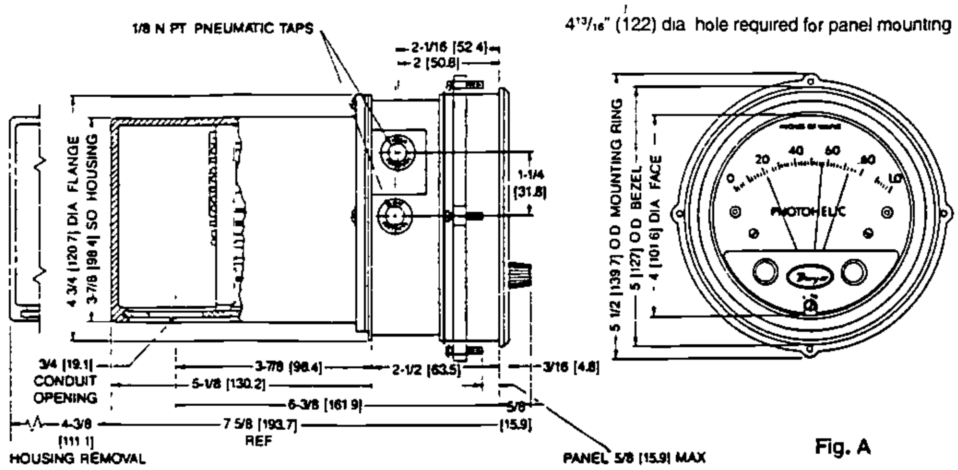


Fig. A

NOTE: Detailed dimension drawings are available from our Customer Service Dept for PHOTOHELIC® switch/gages as installed in two optional enclosures For weatherproof housing, request no 13-700132-00 For explosion-proof housing, request no 13-700113-01

The **PHOTOHELIC® Series A3000** is a versatile 2-in-1 instrument combining a time-proven Magnehelic® differential pressure gage with low/high pressure switches. It is designed to measure and control positive, negative or differential pressure of air or other non-combustible, non-corrosive gases Gage reading is unaffected by switch operation. Switch set points are easily adjusted with knobs located on gage face. Applied pressure and switch set points are fully visible at all times. Deadband is one pointer width, less than 1% of full scale. Each set point controls a DPDT relay and both relays can be interlocked to provide variable deadband control.

PHYSICAL DATA

Ambient Temperature Range: 20 to 120°F (-6.7 to 49°C)

Maximum Pressure: Std , 25 PSIG (1.75 kg/cm²); MP option - 35 PSIG (2.46 kg/cm²); HP option – 80 PSIG (5 62 kg/cm²)

Accuracy: ±2% of full scale at 70°F (21 1°C)

Pressure Connections: (2) 1/8" NPT female

Case Finish: Baked dark gray epoxy enamel

Conduit Opening: 3/4"

Standard Accessories: (2) 1/8" NPT adapters for 3/16" ID rubber or vinyl tubing, (1) mounting ring, (1) snap ring, (4) 6-32×2" mounting screws and instructions.

Compatibility: Use only with air or other non-combustible, non-corrosive gases.

Weight: 4 lbs , 12 oz. (2.15 kg)

Power Supply: 120 VAC, 50/60 Hz Std. 240 VAC optional, see label

Current Consumption: 5 watts average

Contact Ratings: 10 A @ 28 VDC or 120/240 VAC; 1/3 HP @ 120/240 VAC

INSTALLATION

1. Location: Select a clean, dry, vibration-free location where ambient temperatures will be between 20 and 120°F (-6.7 and 49°C). Tubing supplying pressure to the instrument can be practically any length but long runs will increase response time slightly.

2. Position: The PHOTOHELIC® Switch/Gage is factory calibrated for use with scale in a vertical plane. Operation at other angles may affect accuracy and/or require zero adjustment. Most models can be specially calibrated at the factory for other positions if specified at time of ordering. Ranges below 1" W.C. must be used only with scale vertical.

3. Mounting: The PHOTOHELIC® is normally mounted before making electrical connections. The electrical enclosure is removable at any time regardless of mounting method.

(A) Panel Mounting: Normal mounting is flush or through panel as shown in Fig. B. Allow 4-3/8" (112 mm) clearance behind the unit for removal of electrical enclosure. Make a 4-13/16" (122 mm) diameter hole in panel. Insert the PHOTOHELIC® unit from front of panel and slip mounting ring over case from behind with stepped side facing rear. Fit the snap ring into narrow groove at back edge of the bezel Thread four 6-32×1-1/4" mounting screws into tapped holes in mounting ring and seat it against snap ring. Tighten screws against back of panel. See Fig. B.

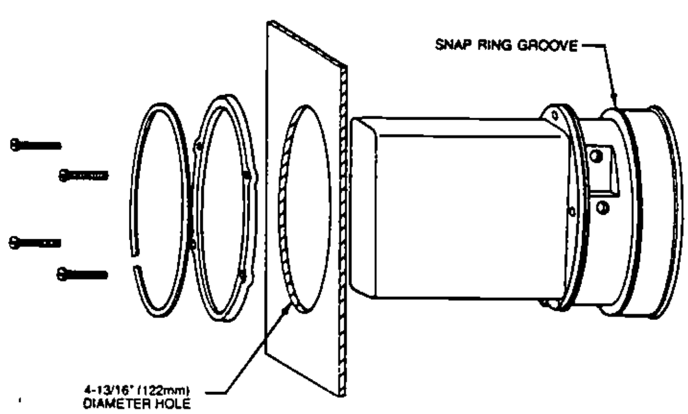


Fig. B

DWYER INSTRUMENTS, INC.
P. O. BOX 373 • MICHIGAN CITY, INDIANA 46360, U.S.A.
Telephone 219/879-8000
Fax 219/872-9057

(B) Surface Mounting with Remote Relays: Where it is preferred to mount the amplifier-relay unit separate from the gage assembly, the gage is mounted as shown in Fig B (without amplifier-relay package) or surface mounted as shown in Fig. C. Use the dimensions in Fig. D to locate holes.

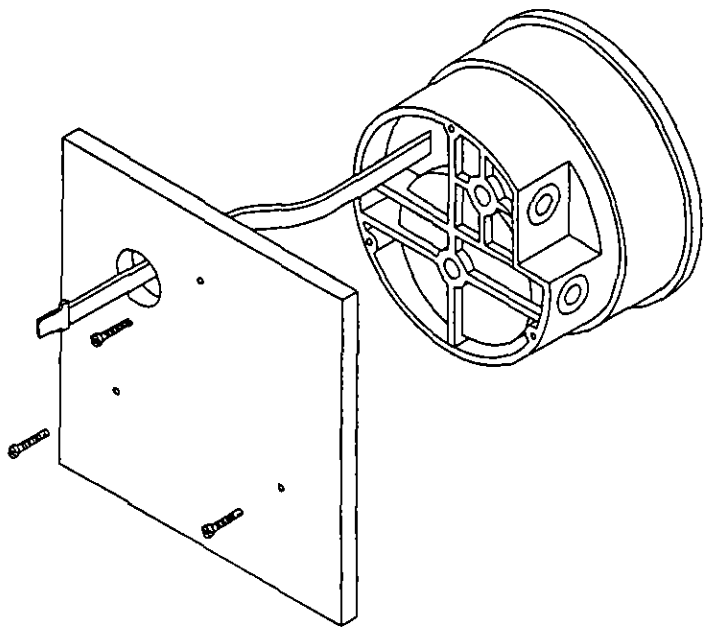


Fig. C

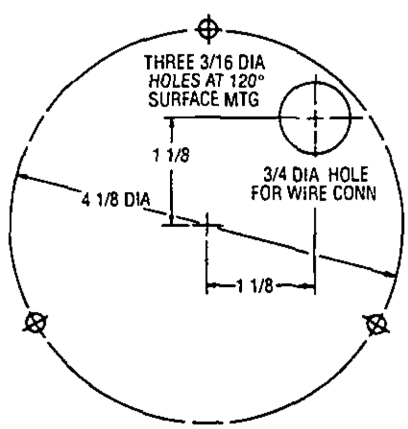


Fig. D

(C) Remote Relays Mounting: On factory supplied RMR (remote mounted relay) units, the amplifier-relay package will be furnished attached to a mounting plate as shown in Fig. E Use the hole layout in Fig. F for this option. A five foot cable assembly is included for connecting the two components. Longer cable lengths are available from the factory.

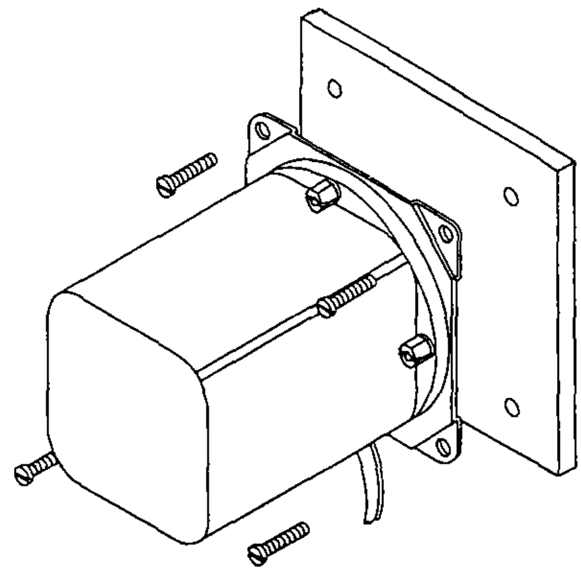


Fig. E

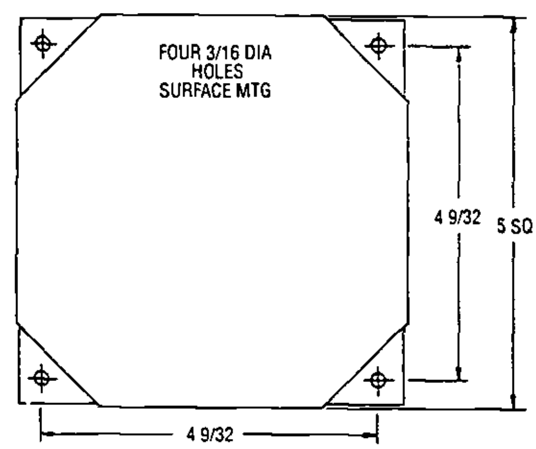


Fig. F

4. Pneumatic Connections & Zeroing: After installation but before making pressure connections, set the indicating pointer exactly on the zero mark, using the zero adjust screw located at the bottom of the front cover. Note that this adjustment can only be made with the high and low pressure taps both open to atmosphere.

Connect the high and low pressure taps to positive, negative, or differential pressure sensing points. Use 1/4" diameter metal or other instrument tubing and 1/8" N.P.T. adaptors at the PHOTOHELIC® pressure switch/gage. Adaptors for rubber or soft plastic tubing are furnished with the instrument for use where this type of connection is preferred.

If the PHOTOHELIC® is not used to sense differential pressure, one of the pressure taps must be left open to atmosphere. This will allow the reference pressure to enter. In this case, installation of a Dwyer No. A-331 Filter Vent Plug or similar fitting in the reference pressure tap is recommended to reduce the possibility of dust entering the instrument.

NOTE: *If the PHOTOHELIC® switch/gage is over pressured, pointer* may "jump" from full scale back to zero and remain there unt the excess pressure condition is relieved. Users should be awar of possible false zero pressure indications under this condition

685 420

ELECTRICAL CONNECTIONS

1. **Cover:** The amplifier-relay unit has an easy to remove housing. Remove the three (3) screws as shown in Fig. G and slide the housing off. Make all the electrical connections before reinstalling and refastening the housing.

Conduit: Electrical access to the connection box portion of the relay housing is by bottom opening for 3/4" conduit. Use of flexible conduit is recommended. It should be supported from the panel or other suitable surface to prevent the wiring system from exerting undue strain on the instrument. See Fig. G.

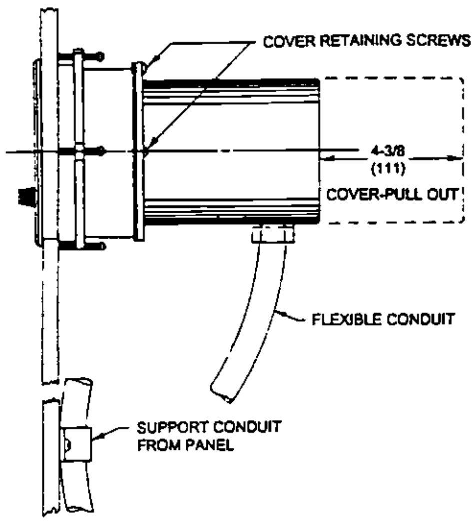
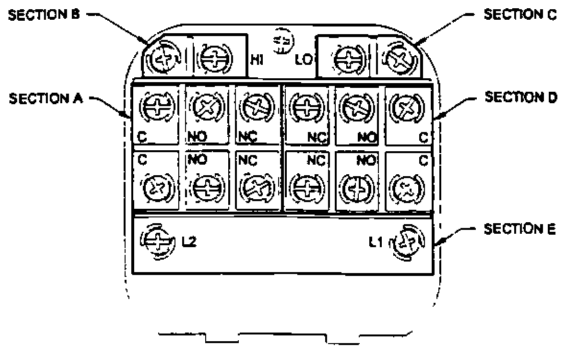


Fig. G

Terminal or Connection Board Layout: In Fig H "Terminal Board," **Section A** contains the connections for the load or slave relay actuated by the high or right set point. This relay is a double pole, double throw type. The two right connections are normally closed, the two middle connections are normally open, and the left connections are the common pair. The relay is in its normal or De-Energized position when pressure is below the right hand set point.

Section D is exactly the same as **Section A** except that its load or slave relay is controlled by the low or left set point. The De-Energized position is below the left hand pointer set point.

Section B contains the external connections to the holding coil circuit for the high or right set point relay and **Section C** contains similar connections for the low or left set point relay The function and use of these connections varies somewhat depending on the circuit style of the instrument. See paragraphs 5 and 6 for details.



CAUTION: Do not apply electrical current to terminals in Sections B and C

Fig. H

Section E contains the power connections for the control unit transformer primary The transformer in turn supplies reduced voltage power for the LED, phototransistor, amplifier unit, and load relay pull in and holding coils. Connections must always be made to this section in order to put the unit in operation. Standard units are designed for 120 VAC input to the transformer. Special units are also available for other voltages.

Separate Ground Wire attachment is provided for by a No. 6-32 screw on the mounting bracket near the conduit opening. An additional ground wire connection is located on the side of the gage body for use when the amplifier-relay unit is mounted remotely.

Single Set Point instruments are furnished with the right or high set point components and circuitry in place. These are connected to Sections A and B of the terminal board. The left or low set point components are omitted.

4. **Circuit Style:** The PHOTOHELIC® is available with several factory installed optional internal circuits. They are identified as to style by a label shown in Fig. J. This label is mounted prominently on the terminal board of each instrument. The letter H denotes a circuit in which the relay can be made to latch or remain energized after pressure increase to its set point.

The letter L denotes a circuit in which the relay can be made to latch or remain de-energized after pressure decrease to its set point. Two letters are required to fully identify a dual set point unit. Thus, circuit style HH, which is standard, is a dual set point circuit which has provisions for latching on pressure increase to either set point. Single relay units are identified by the letters SR followed by H for the standard unit or L for the special low latch unit. Units for use with other than standard 120 VAC will be so indicated on the label

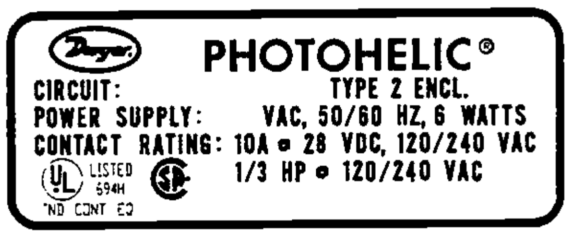


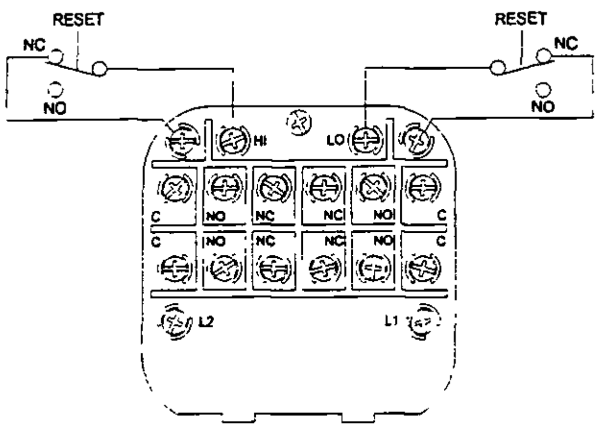
Fig. J

5. **Dual Set Point Automatic Reset:** Circuit Style HH is used for simple on-off switching applications. To place in service, connect load circuits to the appropriate terminals in Section A (Fig. H) for the right set point and Section D for the left set point. Note that the N.O. contacts are open when the gage pressure pointer is to the left of the set point pointers. No connections are necessary in Sections B and C. Make external ground connections as required and connect power to Section E for the control unit. To use circuit style LL for automatic reset, a jumper wire must be installed between the two terminals in Sections B and/or C.

6. **Dual Set Point Manual Reset:** Circuit Style HH may also be used for manual reset applications where it is required to maintain contact on either relay following pressure increase above its set point. Load or signal connections are made to the appropriate terminals in Sections A and D (as in paragraph 5 above). Connect terminals in Sections B and C through normally closed switches or push buttons as shown in Fig. K. Use of "dry-circuit" type switches such as Dwyer Part No. A-601 with paladium, gold, etc. or rotary wiping action type contacts is recommended. Make external ground connections as required and connect power to Section E for the control unit.

685 421

Circuit style LL is used for manual reset applications which require that contact be maintained following pressure decrease below the set point. Load connections are made to the appropriate terminals in Sections A and D. A normally open type manual reset switch such as Dwyer Part No. A-601 is connected to the terminals in Sections B and C. The circuit must be "armed" by momentarily closing the switch while the black pointer is to the right of the set point. From that point on, the circuit will latch on pressure decrease below the set point and remain latched on pressure increase until manually reset with the optional switch.



CAUTION: Do not apply electrical current to terminals in Sections B and C

Manual Reset with Circuit HH

Fig. K

7. Dual Set Point Automatic and Manual Reset Combinations: Circuit Style HH may be used with either set point wired and operating as in paragraph 5 above and the other set point wired and operating as in paragraph 6.

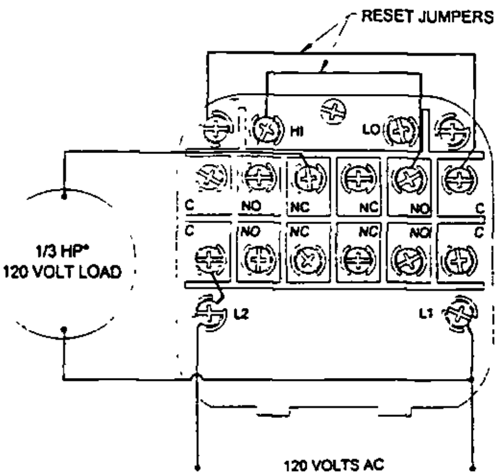
8. High Low Limit Control - Dual Set Point: Circuit Style HH may be used to control fans, dampers, pumps, etc., between the set points of a PHOTOHELIC® To accomplish this, use one set point relay to reset the other as shown in the wiring diagram Fig. L. In this typical application, the load (for instance a fan) would be connected to the N.C. contacts of the right set point relay, Section A (Fig. H). On pressure rise to the right set point, its relay would pull in and hold even though pressure might then fall below that set point. If the pressure continued to fall to the left set point, its relay would automatically be DE-ENERGIZED, return to its normal position and in so doing, open the holding coil circuit from Section B (Fig. H). The right set point relay would thus be reset and the cycle could repeat.

9. Dual Set Point Special Purpose Circuits: Circuit Style LL may be used where manual reset following maintained contact on pressure decrease to either set point is required. Circuit Styles HL and LH are combination units. For special combinations of features, special units, and detailed instructions regarding their use, consult the factory.

10. Single Set Point PHOTOHELIC:® The single set point PHOTOHELIC® is furnished with the right set point only. Terminals in Sections A and B (Fig. H) are connected to this relay. Circuit Style SRH is wired for automatic reset as in paragraph 5 above. Manual reset is accomplished by adding a normally closed reset switch or push button to the circuit as described in paragraph 6 above.

11. Single Set Point Special: Manual reset after actuation on falling pressure can be obtained by using Circuit Style SRL. Consult the factory for special units and detailed instructions regarding their use.

12. Placing in Service: In normal operation each relay is de-energized when the pressure applied to the instrument is below its set point. Special low-latching units will ordinarily have to be reset before placing on the line in normal operation.



**Note For larger motors, use the Photohelic® in a maintained contact, 120 Volt Control or Push Button Circuit of the motor starter.*

Fig. L

13. Failure Mode: The PHOTOHELIC® circuit design provides certain protection in the event of a loss of pressure or electrical power. In either case, both relays will de-energize, returning to their normal "zero pressure" state. The exceptions to this are models with center zero ranges. Because the relays on all standard models are always energized when the indicating (black) pointer is to the right of their respective set points, the relay action on loss of pressure will depend on set point position, since either of them could be located to the left of zero. As an example; if the left pointer were set at –2 in. w.c. and negative pressure was –3 in. w.c., a loss of that pressure would allow the black pointer to return to the center and thus cause the low set point relay to energize.

If the LED should burn out, only the left-low relay will de-energize. The right-high relay will react as if pressure were above its set point and will remain energized even though pressure might be below that setting. In this situation, only termination of electrical power will allow the right-high relay to de-energize.

MAINTENANCE AND SERVICE

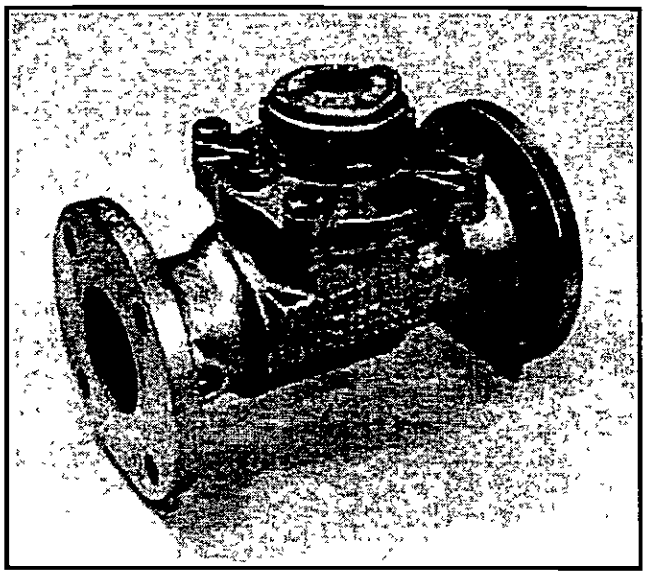
Dwyer PHOTOHELIC® Switch/Gages are precision instruments, expertly assembled and calibrated at the factory. They require no lubrication or periodic servicing. If the interior is protected from dust, dirt, corrosive gases and fluids, years of trouble-free service may be expected. Zero adjustment should be checked and reset occasionally to maintain accuracy. Any repairs necessary to either the Dwyer Magnehelic® pressure gage or the electronic components should be performed by a trained instrument mechanic. In most cases, this is best accomplished by returning the complete PHOTOHELIC® Switch/Gage to the Dwyer factory.

Printed in U.S.A. 12/93 FR 13-440202-04

DWYER INSTRUMENTS, INC.
P.O. Box 373, Michigan City, Indiana 46360, U.S.A.
Phone: 219/879-8000 Fax: 219/872-9057

685 422

Master Meter, Inc.
1 1/2" to 12" MMT Turbine Meters



AWWA Standard
Meets or exceeds all sections of AWWA Standard C-701, Class II Turbines, most recent revision.

Description
Main cases of durable waterworks bronze for 1 1/2" to 8", and cost-effective cast iron for 10" and 12", provide performance, strength and endurance. A nylon inlet flow straightener conditions flows for measurement and screens larger debris. The meters' streamlined flow patterns provide low head loss, reducing the energy required for water delivery. All MMTs incorporate flanged ends.

High strength, precision molded polypropylene rotors insure high accuracy and long service life. MMT Turbines are designed to minimize the net gravitational and buoyant forces on the rotor. The low loads mean high accuracy at lower flows, extended flow ranges to allow meter downsizing without accuracy loss, and lower bearing wear for extended life.

Applications
Designed for cold, clean water utility and industrial installations where flow variations are in a 100:1 range.

Register

Options
Standard: meter-mounted register with mechanical odometer.
DIALOG® System: for automatic electronic reading.
Electrical Output: for remote totalization.
Rate of Flow: for remote flow rate data or input to 4-20 mA output unit.

Registration Units
Registration available in U.S. gallons, cubic feet or cubic metres.

Register Sealing
All registers are permanently sealed, with a stainless steel base and wrap-around gasket to prevent intrusion of dirt or moisture. Direct read and DIALOG System registers incorporate a tempered glass lens.

Meter Operating Characteristics & Dimensions

685 423

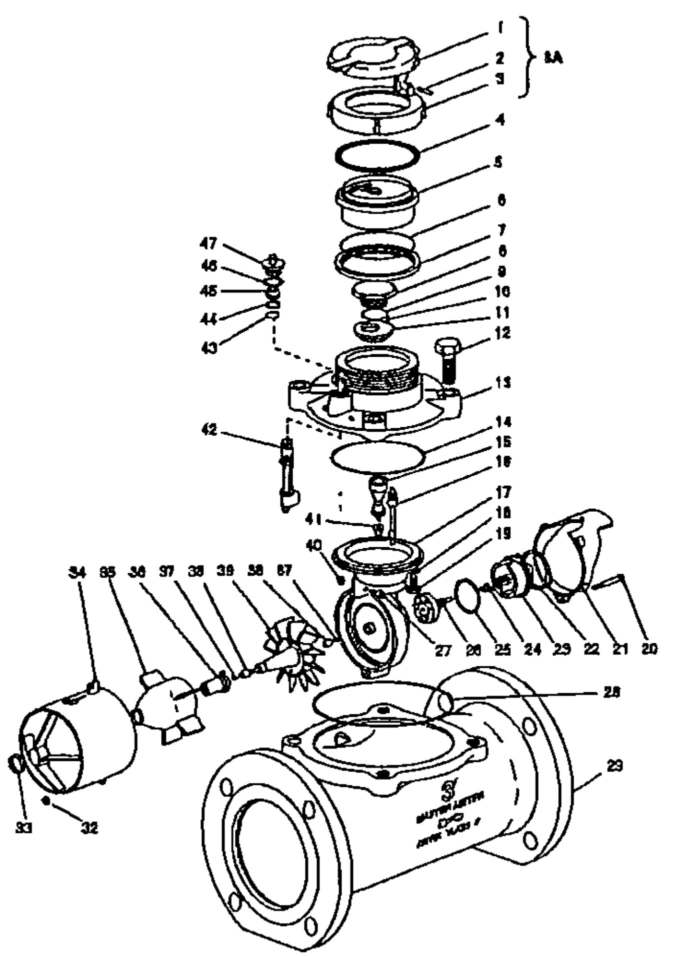
1 1/2" to 12" MMT Turbine Meters
Meter Operating Characteristics & Dimensions

	Meter Size			
Characteristic/Dimension	**1 1/2"**	**2"**	**3"**	**4"**
Operating Range (±1 1/2%) [gpm]	3-160	4 - 350	5 - 530	9 - 1350
Continuous Operating Range [gpm]	3-120	4 - 200	5 - 400	9 - 1000
Low Flow (gpm)	2.5	3	4	8
Maximum Intermittent Flow [gpm]	160	350	530	1350
Maximum Working Pressure (psi)	175	175	175	175
Maximum Working Temperature (°F)	120	120	120	120
Length (inches)	10	10	12.2	14.2
Height (inches)	6.7	8.6	9.6	10.2
Height bottom to center line (inches)	2.2	2.9	3.8	4.4
Width (inches)	5.3	5.9	7.6	9.2
Weight (pounds)	15.6	24	37	42
Register Capacity (millions) - U.S. Gal.	100	100	100	1,000
Register Capacity (millions) - Cu. Ft.	10	10	10	100
Maincase Material	Bronze	Bronze	Bronze	Bronze
Flanges	Elliptical	Elliptical	Round	Round

	Meter Size			
Characteristic/Dimension	**6"**	**8"**	**10"**	**12"**
Operating Range (±1 1/2%) [gpm]	25 - 2700	35 - 3500	60 - 6500	180 - 8800
Continuous Operating Range [gpm]	25 - 2300	35 - 2700	60 - 3300	180 - 4400
Low Flow (gpm)	20	27	44	50
Maximum Intermittent Flow [gpm]	2700	3500	6500	8800
Maximum Working Pressure (psi)	175	175	175	175
Maximum Working Temperature (°F)	120	120	120	120
Length (inches)	18.3	20.3	18.0	20.0
Height (inches)	12.8	13.5	17.5	18.6
Height bottom to center line (inches)	5.6	6.4	8.1	9.2
Width (inches)	11.2	13.7	16.2	18.4
Weight (pounds)	108	140	167	211
Register Capacity (millions) - U.S. Gallons	1,000	10,000	10,000	10,000
Register Capacity (millions) - Cu. Ft.	100	1000	1000	1000

3" MMT Turbine Meter

Parts List



Illus. #		Description	Part #
1		Lid	27621209
2		Hinge Pin	26710709
3		Cover Ring	25820210
3A		Register Cover Assembly	25820419
4		Sliding Ring	23142309
5		3" MMT Sealed Register	
5A		Standard Register, gallons	54003309
5B		Standard Register, cubic feet	54003509
5C		DIALOG® Register, gallons	54003609
5D		DIALOG® Register, cubic feet	54003809
6		Register O-Ring	20613009
7		Pressure Ring	23142609
8		Upper Spindle Bearing Assembly	21140019
9		O-Ring	20612709
10		Up-shaft Cover Screw	21260009
11		Up-Shaft Cover	23423509
12		Cover Bolt	21082109
13		Cover Plate	25250109
14		Measuring Chamber O-Ring	20602909
15	T	Driver Magnet Holder Assembly	26731219
16	T	Up-shaft Assembly	26731119
17	T	Chamber Housing	27042209
18	T	Chamber Mounting Plate Washer	23025709
19	T	Bolt	21081709
20	T	Flow Tube Bolt	21280209
21	T	Downstream Flow Tube	24626609
22	T	Transmission Locking Ring	23160709
23	T	Transmission Housing	25285109
24	T	Transmission Up-shaft Bushing	24900909
25	T	Transmission Housing O-Ring	20603409
26	T	Worm Assembly	26700319
27	T	Chamber Locking Screw	21110509
28		Cover O-Ring	20603509
29	T	3" MMT Bronze Body	34230109
32	T	Chamber Locking Nut	20382109
33	T	Flow Straightener Nut	20382209
34	T	Upstream Flow Tube	26354209
35	T	Flow Straightener	25041209
36	T	Rotor Nose Cone	21480809
37	T	Carbide Thrust Bearing	24902909
38	T	Rotor Bearing	28535009
39	T	Rotor Assembly	23743119
40	T	Chamber Locking Nut	20382609
41	T	Driver Magnet Bushing	24900409
42	T	Adjustment Vane	26510309
43	T	Adjustment Vane O-Ring	20602609
44	T	Adjustment Vane Sealing Ring	23126109
45	T	Adjustment Vane Locking Nut	20382709
46		Adjustment Vane Cover O-Ring	20602709
47		Adjustment Vane Cover	21082009

T = Testing and re-calibration is recommended when this part is replaced.

MASTER METER

1001 McKesson Drive • Longview, Texas 75604 • 1-800-765-6518 • 1-903-297-0635 • FAX: 1-903-297-5963

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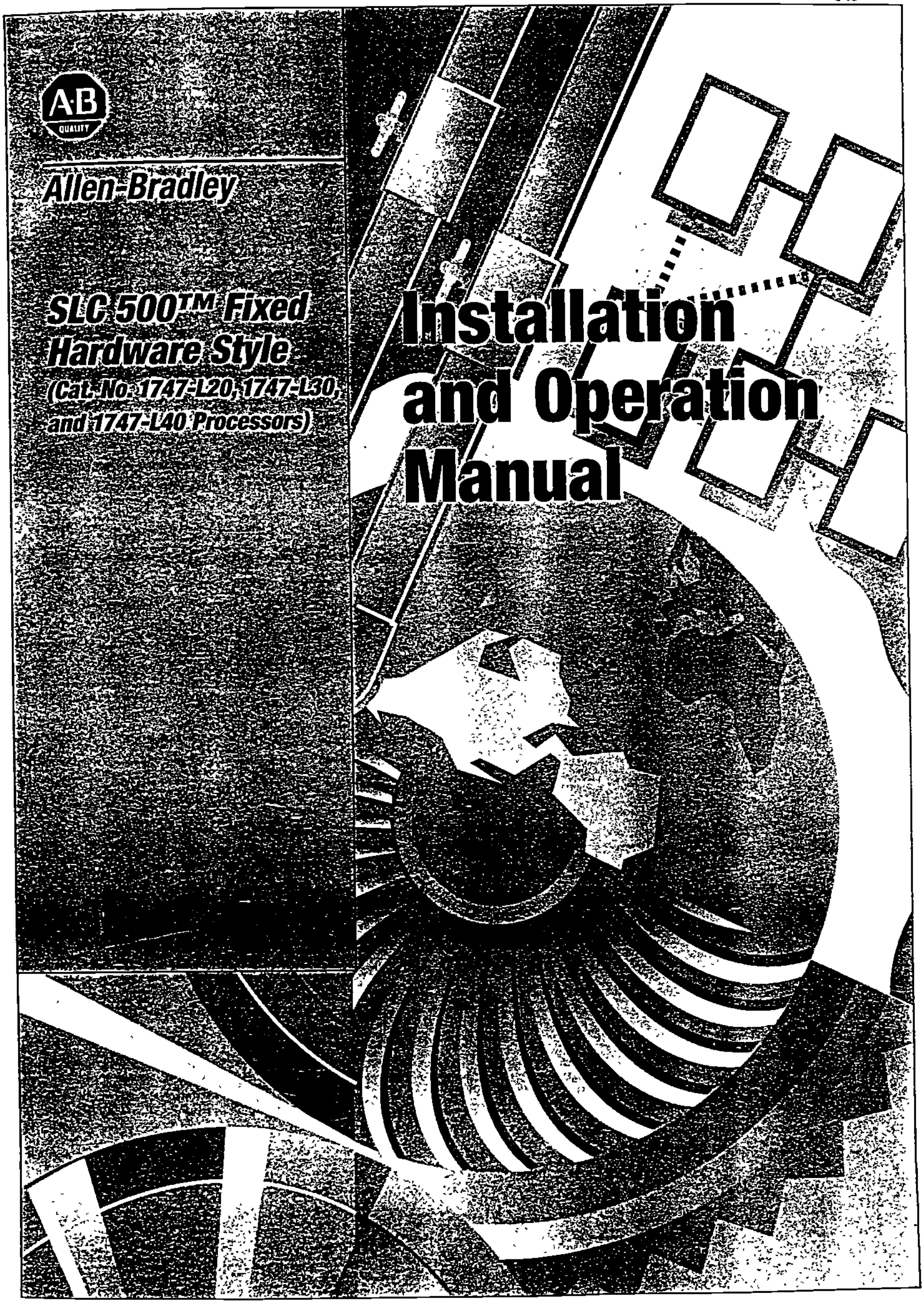
685 424

Allen-Bradley

Installation and Operation Manual

SLC 500™ Fixed Hardware Style

(Cat. No. 1747-L20, 1747-L30, and 1747-L40 Processors)



Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. "Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls" (Publication SGI-1.1) describes some important differences between solid state equipment and hard–wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will the Allen-Bradley Company be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, the Allen-Bradley Company cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Allen-Bradley Company with respect to use of information, circuits, equipment, or software described in this manual.

Throughout this manual we use notes to make you aware of safety considerations.

⚠ **ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

Attentions help you:

- identify a hazard
- avoid the hazard
- recognize the consequences

Important: Identifies information that is especially important for successful application and understanding of the product.

685 427

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685 429

Summary of Changes

The information below summarizes the-changes to this manual since the last printing as 1747-NI001 in November, 1993.

To help you find new information and updated information in this release of the manual, we have included change bars as shown to the right of this paragraph.

New Information

The table below lists sections that document new features and additional information about existing features, and shows where to find this new information.

For This New Information	See
Updated list of related publications	Preface
High voltage warning	Chapters 2, 4, and 7

Preface

Chapter 1
Selecting Your Hardware Components

System Installation Recommendations

Chapter 2

Mounting Your SLC 500 Control System

Chapter 3

Installing Your Hardware Components

Chapter 4

685 432

Wiring Your Control System

Chapter 5

Starting Up Your Control System

Chapter 6

Maintaining Your Control System

Chapter 7

685 433

Troubleshooting

Chapter 8

Replacement Parts

Chapter 9

Setting Up the DH–485 Network

Appendix A

The 1771–Remote I/O Network

Appendix B

RS–232 Communication Interface

Appendix C

685 435

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Calculating Heat Dissipation for the SLC 500 Control System

Appendix D

Wiring and Circuit Diagrams and Voltage Ranges for Your Fixed Controller

Appendix E

Glossary

Preface

Read this preface first. It provides an overview of the entire manual and will acquaint you with the information that is provided throughout these pages. In this preface, you will learn about:

- who should use this manual
- how to use this manual
- related publications
- conventions used in this manual
- Allen–Bradley support

Who Should Use this Manual

The tasks and procedures in this manual require you to have some knowledge of programmable controller installation and electrical wiring. We also assume that you have a "working" knowledge of SLC™ products. If you do not have this knowledge base, obtain the proper training before attempting any of the tasks and/or procedures detailed in this manual.

How to Use this Manual

As much as possible, we organized this manual to explain, in a task–by–task manner, how to install and operate (preliminary start–up operations) the SLC 500 fixed programmable controller. This manual also provides some system design information.

Before using this manual, read over the table below and familiarize yourself with the general content of the chapters and appendixes. If you already have a topic in mind that you want to find specific information about, turn to the index at the back of the manual.

If You Want	See
An overview of the manual	The Preface
Information on how to select certain components for your SLC 500 control system	Chapter 1 — Selecting Your Hardware Compone
A guide on how to prepare for the installation of your control system	Chapter 2 — System Installation Recommendati
Mounting dimensions of your fixed controller, DTAM ™, and/or 1747–AIC	Chapter 3 — Mounting Your SLC 500 Control Sy
Procedures on how to install your hardware components	Chapter 4 — Installing Your Hardware Compone
Information on how to wire the components of your SLC 500 control system	Chapter 5 — Wiring Your Control System
A guide on how to start up your control system	Chapter 6 — Starting Up Your Control Sy
Information on how to maintain your control system	Chapter 7 — Maintaining Your Control System
To identify error messages generated by your control system	Chapter 8 — Troubleshooting
To replace parts of your SLC 500 control system or purchase other SLC components	Chapter 9 — Replacement Parts
Information on setting up the DH–485 network	Appendix A — Setting Up the DH–485 Network
Information on the 1771–Remote I/O network	Appendix B — The 1771–Remote I/O Network
Information on configuring the RS–232 network	Appendix C — RS–232 Communication Interface
Information on how to calculate the heat dissipation of your controller	Appendix D — Calculating Heat Dissipation for th SLC 500 Control System
Wiring and circuit diagrams and voltage ranges	Appendix E — Wiring and Circuit Diagrams and Voltage Ranges for Your Fixed Controller
Definitions of terms used in this manual	The Glossary

Related Publications

The table below provides a listing of publications that contain important information about Allen–Bradley Small Logic Controllers and their installation and application. You may want to reference them while you are installing the SLC 500 controller. (To obtain a copy of one of these publications, contact your local Allen–Bradley office or distributor.)

For	Read this Document	Document Number
An overview of the SLC 500 family of products	SLC 500 System Overview	1747–2.30
A description on how to install and use your *Modular* SLC 500 programmable controller	Installation & Operation Manual for Modular Hardware Style Programmable Controllers	1747–6.2
A procedural manual for technical personnel who use APS to develop control applications	Advanced Programming Software (APS) User Manual	9399–APSUM
A reference manual that contains status file data, instruction set, and troubleshooting information about APS	SLC 500™ and MicroLogix™ 1000 Instruction Set Reference Manual	1747–6.15
An introduction to APS for first–time users, containing basic concepts but focusing on simple tasks and exercises, and allowing the reader to begin programming in the shortest time possible	APS Quick Start for New Users	9399–APSQS
A procedural and reference manual for technical personnel who use the APS import/export utility to convert APS files to ASCII and conversely ASCII to APS files	APS Import/Export User Manual	9399–APSIE
A procedural and reference manual for technical personnel who use an HHT to develop control applications	Allen–Bradley Hand–Held Terminal User Manual	1747–NP002
An introduction to HHT for first–time users, containing basic concepts but focusing on simple tasks and exercises, and allowing the reader to begin programming in the shortest time possible	Getting Started Guide for HHT	1747–NM009
In–depth information on grounding and wiring Allen–Bradley programmable controllers	Allen–Bradley Programmable Controller Grounding and Wiring Guidelines	1770–4.1
A description on how to install a PLC–5® system	PLC–5 Family Programmable Controllers Hardware Installation Manual	1785–6.6.1
A description of important differences between solid–state programmable controller products and hard–wired electromechanical devices	Application Considerations for Solid–State Controls	SGI–1.1
An article on wire sizes and types for grounding electrical equipment	National Electrical Code	Published by the National Fire Protection Association of Boston, MA.
A complete listing of current Automation Group documentation, including ordering instructions. Also indicates whether the documents are available on CD–ROM or in multi–languages.	Allen–Bradley Publication Index	SD499
A glossary of industrial automation terms and abbreviations	Allen–Bradley Industrial Automation Glossary	AG–7.1

Conventions Used in this Manual

The following conventions are used throughout this manual:

- Bulleted lists such as this one provide information, not procedural steps.
- Numbered lists provide sequential steps or hierarchical information.
- *Italic* type is used for emphasis.
- Dimensions are in millimeters. (Dimensions in parentheses are in inches.)
- Text in `this font` indicates words or phrases you should type.

Allen–Bradley Support

Allen–Bradley offers support services worldwide, with over 75 Sales/Support offices, 512 authorized Distributors and 260 authorized Systems Integrators located throughout the United States alone, plus Allen–Bradley representatives in every major country in the world.

Local Product Support

Contact your local Allen–Bradley representative for:

- sales and order support
- product technical training
- warranty support
- support service agreements

Technical Product Assistance

If you need to contact Allen–Bradley for technical assistance, please review the information in the Troubleshooting chapter first. Then call your local Allen–Bradley representative.

Your Questions or Comments on this Manual

If you have any suggestions for how this manual could be made more useful to you, please send us your ideas on the enclosed reply card.

If you find a problem with this manual, please notify us of it on the enclosed Publication Problem Report.

Chapter 1

Selecting Your Hardware Components

This chapter provides general information on what your SLC 500 controller can do for you and an overview of the fixed control system. It also explains how to select:

- 2–slot chassis
- discrete I/O modules
- specialty I/O modules
- enclosures
- operator interfaces
- memory modules
- isolation transformers
- suppressors
- output contact protection

There is also a section on special considerations for controller installations.

This chapter does not provide you with all the information that you need to select a complete SLC 500 control system. To do this, we recommend that you use the latest version of the system overview, *SLC 500 Family of Small Programmable Controllers*, Publication Number 1747–2.30.

What Your SLC 500 Controller Can Do for You

The SLC 500 programmable controller has features that previously could only be found in large programmable controllers. It has the flexibility and power of a large controller with the size and simplicity of a small controller. The SLC 500 controller offers you more control options than any other programmable controller in its class.

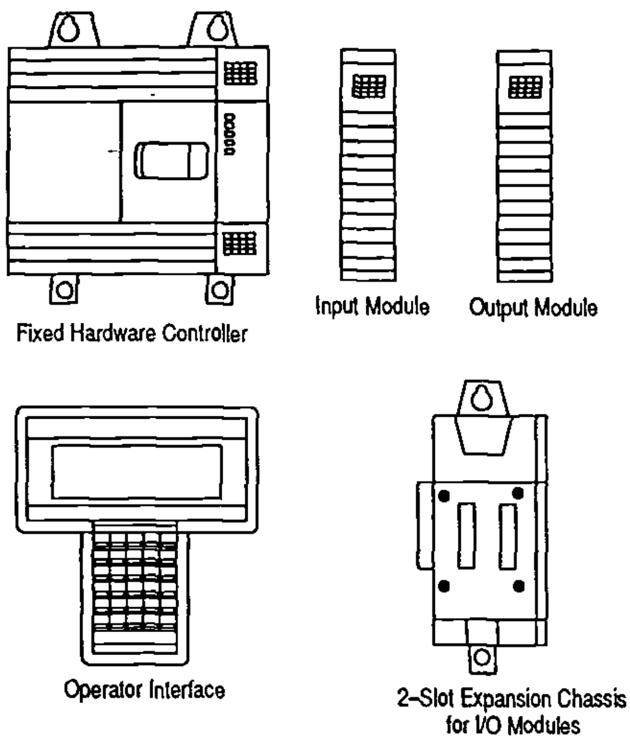
These programmable controllers make up a technologically advanced control system having inherent flexibility and advantages characteristic of other programmable controllers, but with one important difference — simplicity!

685 445

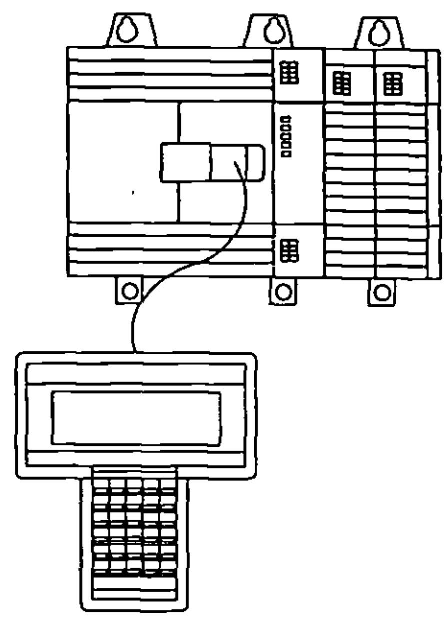
Overview of Your Fixed Control System

The basic fixed controller consists of a processor with 1,024 (1K) instruction capacity, a power supply, and a fixed number of I/O contained in a single package. The figure below shows typical hardware components for a fixed controller.

Fixed Hardware Components



Fixed Controller with 2-slot Expansion Chassis



Fixed Controller Specifications

This section provides the specifications for the SLC 500 Fixed Controller.

Description	Specification
Memory Type	Capacitor–backed RAM memory. Battery back–up optional.
Memory Backup Options	EEPROM or UVPROM
Program Memory	1K Instruction Capacity
Capacitor Memory Back–up Time	Refer to curve on page 1–4.
Battery Life	5 years
Typical Scan Time ①	8 milliseconds/1K
Bit Execution (XIC)	4 microseconds
Program Scan Hold–up Time after Loss of Power	20 milliseconds to 700 milliseconds (dependent on loading)
Power Supply Operating Voltage	AC units: 85–265 VAC 47–63 Hz DC units: 21.6–26.4 VDC (24 VDC ± 10%)
Power Supply Fuse Protection	AC units: 120/240 VAC 1.25A DC units: 24 VDC 1.6A
Power Supply Inrush Rating	30 Amperes maximum
Maximum Power Requirement	50 VA ②
24 VDC User Power Output Current ③	200mA
24 VDC User Power Output Voltage ③	20.4 – 27.6 VDC (24 VDC ± 15 %)
Wire Size	#14 AWG Max.
I/O Electrical–Optical Isolation	1500 VAC at 1 minute
1747–AIC Link Coupler Electrical–Optical Isolation	1500 VDC
LED Indicators	POWER, PC RUN, CPU FAULT, FORCED I/O, and BATTERY LOW
Noise Immunity	NEMA Standard ICS 2–230
Ambient Temperature Rating	Operating: 0°C to +60°C (+32°F to +140°F) Storage: –40°C to +85°C (–40°F to +185°F)
Humidity	5 to 95% without condensation
Vibration	Displacement: .015 inch, peak–to–peak @ 5–57 Hz
	Acceleration: 2.5 Gs @ 57–2000 Hz
	Duration: 1 hr per axis (x, y, z)
Certification	UL listed/ CSA approved

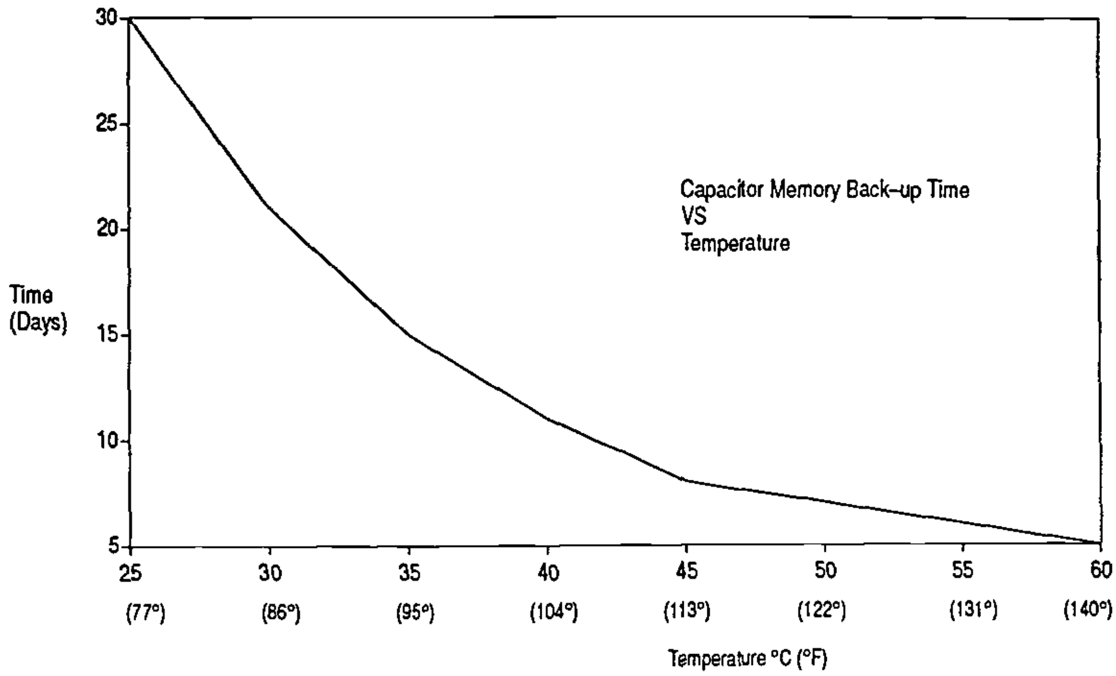
① *The scan times are typical for a 1K ladder logic program consisting of simple ladder logic and communication servicing. Actual scan times depend on your program size, instructions used, and the DH–485 communication.*

② *This specification does not include input and output values (See page 1–6)*

③ *This applies only to fixed controllers that have AC line power and DC input circuits*

Memory Backup for the SLC 500 Fixed Controller

The curve below illustrates the ability of the memory back–up capacitor to maintain the contents of the RAM in a fixed controller. To back up the memory for a longer period of time, a lithium battery, Catalog Number 1747–BA, is required.



Configuration Options

The following table provides configuration options for 20, 30, or 40 I/O points.

Catalog Number	Line Power	I/O Configuration		High-Speed Counter	User Power
		Input	Output		
1747-L20A	120/240 VAC	(12) 120 Volts AC	(8) AC/DC Relay	No	NA
1747-L30A		(18) 120 Volts AC	(12) AC/DC Relay	No	NA
1747-L40A		(24) 120 Volts AC	(16) AC/DC Relay	No	NA
1747-L20B		(12) 120 Volts AC	(8) AC Triac	No	NA
1747-L30B		(18) 120 Volts AC	(12) AC Triac	No	NA
1747-L40B		(24) 120 Volts AC	(16) AC Triac	No	NA
1747-L20C		(12) 24 Volts DC Sink	(8) AC/DC Relay	Yes	24V-200mA
1747-L30C		(18) 24 Volts DC Sink	(12) AC/DC Relay	Yes	24V-200mA
1747-L40C		(24) 24 Volts DC Sink	(16) AC/DC Relay	Yes	24V-200mA
1747-L20D		(12) 24 Volts DC Sink	(8) AC Triac	Yes	24V-200mA
1747-L30D		(18) 24 Volts DC Sink	(12) AC Triac	Yes	24V-200mA
1747-L20E		(12) 24 Volts DC Sink	(8) DC Transistor Source	Yes	24V-200mA
1747-L40E		(24) 24 Volts DC Sink	(16) DC Transistor Source	Yes	24V-200mA
1747-L20L		(12) 24 Volts DC Source	(8) DC Transistor Sink	Yes	24V-200mA
1747-L30L		(18) 24 Volts DC Source	(12) DC Transistor Sink	Yes	24V-200mA
1747-L40L		(24) 24 Volts DC Source	(16) DC Transistor Sink	Yes	24V-200mA
1747-L20R		(12) 240 Volts AC	(8) AC/DC Relay	No	NA
1747-L20P		(12) 240 Volts AC	(8) AC Triac	No	NA
1747-L30P		(18) 240 Volts AC	(12) AC Triac	No	NA
1747-L40P		(24) 240 Volts AC	(16) AC Triac	No	NA
1747-L20F	24 VDC± 10%	(12) 24 Volts DC Sink	(8) AC/DC Relay	Yes	NA
1747-L40F		(24) 24 Volts DC Sink	(16) AC/DC Relay	Yes	NA
1747-L20G		(12) 24 Volts DC Sink	(8) DC Transistor Source	Yes	NA
1747-L20N		(12) 24 Volts DC Source	(8) DC Transistor Sink	Yes	NA

Input Specifications

The following table details the input specifications for SLC 500 Fixed I/O units. See the glossary for a definition of specifications.

Inputs	Specifications	
120 VAC	On–State Voltage	85–132 VAC
	Frequency	47–63 Hz
	Off–State Voltage	30 VAC (maximum)
	Inrush Current	0.8A peak
	Nominal Input Current	12mA at 120 VAC
	Turn–On Time	35 milliseconds (maximum)
	Turn–Off Time	45 milliseconds (maximum)
	Maximum Off–State Current	2mA
240 VAC	On–State Voltage	170–265 VAC
	Frequency	47–63 Hz
	Off–State Voltage	50 VAC (maximum)
	Inrush Current	1.6A peak
	Nominal Input Current	12mA at 240 VAC
	Turn–On Time	35 milliseconds (maximum)
	Turn–Off Time	45 milliseconds (maximum)
	Maximum Off–State Current	2mA
DC Sink & Source	On–State Voltage	10–30 VDC
	Off–State Voltage	4 VDC maximum for input 0 (HSC) 5 VDC for all others
	Nominal Input Current	20mA at 24 VDC (for input 0 only) 8mA at 24 VDC (all others inputs)
	Turn–On Time	8 milliseconds (maximum)
	Turn–Off Time	8 milliseconds (maximum)
	Maximum Off–State Current	1mA

Output Specifications

The following table details the output specifications for SLC 500 Fixed I/O Units.

Outputs	Specifications	
Triac	Output Voltage	85–265 VAC
	Continuous Current (per output)	0.5 Amp at +30°C 0.25 Amp at +60°C (maximum)
	Minimum Load Current	10mA
	Turn–On Time	0.1 milliseconds (maximum)
	Turn–Off Time	10 milliseconds (maximum)
	Maximum Off–State Leakage Current	2mA
	Maximum On–State Voltage Drop	1.5V @ 0.5 Amps
	Maximum Surge Current	*10 Amps for 25 milliseconds*[1]
Transistor Sink & Source	Output Voltage	10–50 VDC
	Continuous Current (per output)	0 5 Amp at +30°C 0 25 Amp at +60°C (maximum)
	Minimum Load Current	1mA
	Turn–On Time	0.1 millisecond (maximum)
	Turn–Off Time	1 millisecond (maximum)
	Maximum Off–State Leakage Current	1mA
	Maximum On–State Voltage Drop	1.5V @ 0.5 Amps
	Maximum Surge Current	3.0 Amps for 25 milliseconds[1]
Relay[3]	Output Voltage Range	5–265 VAC, 5–125 VDC
	Continuous Current (per output)	2.5 Amps (maximum)
	Continuous Current (per group)[2]	8 Amps (maximum)
	Maximum Load (per chassis)	1440 VA
	Turn–On Time	10 milliseconds (maximum)
	Turn–Off Time	10 milliseconds (maximum)
	Maximum Off–State Leakage Current	0mA
	Minimum Load Current at 5 VDC	10mA

[1] *Repeatability is once every 1 second at +30°C. Repeatability is once every 2 seconds at +60°C.*
[2] *Refer to the wiring diagrams for output groupings on the fixed I/O chassis.*
[3] *Surge suppression across the output device is recommended to protect relay contacts*

Relay Contact Ratings

Maximum Volts	Amperes Make	Amperes Break	Amperes Continuous	Voltamperes Make	Voltamperes Break
240 VAC 120 VAC	7.5A 15A	0.75A 1.5A	2.5A	1800 VA	180 VA
125 VDC	0.22A		1.0A	28 VA	
24 VDC	1.2A		2.0A	28 VA	

To calculate make and break ratings for other load voltages, divide the voltampere rating by the load voltage; for example:

28 VA/48 VDC = 0.583 A

Selecting the 2–Slot Chassis

For the 20, 30, and 40 I/O fixed controllers, an optional 2–slot expansion chassis lets you add two additional I/O modules providing even more versatility. The power supply provides backplane power for the modules in the optional expansion chassis.

Refer to chapter 3 for chassis dimensions and chapter 4 for mounting directions.

Selecting Discrete I/O Modules

There are three types of I/O modules: input, output, and combination I/O. They are available in a wide variety of densities including 4, 8, 16, and 32 point and can interface to AC, DC, and TTL voltage levels. Output modules are available with solid–state AC, solid–state DC, and relay contact type outputs.

For a complete, up–to–date listing of discrete I/O modules and their specifications, contact your Allen–Bradley sales office for the latest product data entitled *Discrete Input and Output Modules*, Publication Number 1746–2.35.

Refer to chapter 4 for installation directions.

Selecting Speciality I/O Modules

The SLC 500 family offers specialty I/O modules that enhance your control system. These modules range in function from analog interface to motion control, from communication to high–speed counting.

For a complete, up–to–date listing of specialty I/O modules and their specifications, contact your Allen–Bradley sales office for the latest System Overview entitled *SLC 500 Family of Small Programmable Controllers*, Publication Number 1747–2.30, or for a related product data.

Refer to chapter 4 for installation directions.

Selecting Enclosures

The enclosure protects the equipment from atmospheric contamination. Standards established by the National Electrical Manufacturer's Association (NEMA) define enclosure types, based on the degree of protection an enclosure will provide. Use a fan to circulate the air of sealed enclosures that use convection cooling to dissipate heat. Select a NEMA–rated enclosure that suits your application and environment. The enclosure should be equipped with a disconnect device. To calculate the heat dissipation of your controller, see appendix D.

Selecting Operator Interfaces

Use an operator interface to program and/or monitor your SLC 500 controller. You can choose from several Allen–Bradley operator interface devices.

Programming with a Hand–Held Terminal (1747–PT1)

Use the Hand–Held Terminal (HHT) to configure the SLC 500 controller, enter/modify a user program, download/upload programs, monitor control operation, and test/troubleshoot. When equipped with a battery (1747–BA), the HHT retains a user program in memory for storage and later use.

The display area accommodates 8 lines x 40 characters. You can display five rungs of a user program. The top row of keys are the menu function keys.

Important: Using the HHT, you can program the SLC 5/01™ and 5/02™ processors and the SLC 500 fixed controllers. You cannot, however, program the SLC 5/03 processor.

Refer to the *Hand–Held Terminal User Manual*, Catalog Number 1747–NP002, for information on programming your fixed controller with the HHT.

Programming with Advanced Programming Software (APS) on an IBM Compatible Computer

The Advanced Programming Software (APS) can be used with an Allen-Bradley T45, T47, or T50 terminal, an IBM®-AT or XT, a Compaq® Portable, Portable II, Deskpro™ 286, 386/SX, 386, a Tandy™ 3000HL, Toshiba™ 3100E, or GATEWAY 2000™ models 386DX/25, 386DX/33, 486DX/33, and 486DX2/50 personal computer. Your computer must have:

- 640 Kbytes of RAM (extended or expanded memory is recommended, but not required)
- 10 Mbyte fixed-disk drive (APS requires a minimum or 2.5 MBytes of free disk space.)
- DOS version 3.1 or higher

Advanced Programming Software, 1747–PA2E

APS, Catalog Number 1747–PA2E, comes on 5–1/4 and 3–1/2 inch disks. You must have DOS installed in your computer. You also must have at least 550 Kbytes of free memory to execute the APS software. Like the Hand–Held Terminal, APS lets you configure the SLC 500 controller, enter/modify a user program, restore/save programs to the SLC 500, monitor controller operation, and test/troubleshoot. You can also:

- create and print ladder diagrams, data tables, instruction cross references, and configurations
- use cut/copy/paste editor
- store multiple programs in the memory of the computer (on the hard disk)

Refer to the *Advanced Programming Software User Manual*, Catalog Number 1747–NM002, and the *Advanced Programming Software Reference Manual*, Catalog Number 1747–NR001, for information on programming your fixed controller with APS.

DH–485 Interface Converter (1747–PIC)

For communication, use an RS–232/DH–485 Interface Converter between the computer and SLC controller. The converter includes a 279.4 mm (11.0 in.) ribbon cable, already attached to the converter, for connection to the computer serial port and a Catalog Number 1746–C10 cable for connection to the controller.

Monitoring with a Data Table Access Module (1747–DTAM–E)

The Data Table Access Module (DTAM) is a plant floor device that lets you access data file information, change operating modes, monitor and clear processor faults, and transfer the user program between RAM and an EEPROM memory module with any SLC 500 family processor. *You cannot use it to create new programs.*

Important features of DTAM include:

- shorthand addressing, which provides easier access to data files
- display prompts in six, user–selectable languages: English, French, German, Italian, Spanish, and Japanese
- UL listed, CSA Certified
- NEMA type 12 and 13 enclosures
- point–to–point interface to an SLC family processor, or as a network device on a DH–485 network

Refer to the *Data Table Access Module (DTAM) User Manual*, Catalog Number 1747–ND013, for information on monitoring your fixed controller with the DTAM.

EEPROM and UVPROM Memory Modules

These optional memory modules provide a non–volatile memory back–up in a convenient modular form. The modules plug into a socket on the controller.

You can store (save) your program in the EEPROM by inserting it into the processor and using either the Hand–Held Terminal or Advanced Programming Software.

Use of the UVPROM provides you with an extra degree of program security because the user program cannot be altered while it is installed in the controller. You can program the UVPROM with commercially available UVPROM programming and erasing equipment. You can use an EEPROM module as a master, or you can use an archived processor file as the source by using the APS PROM translator utility.

Adapter sockets are required when inserting memory modules into commercially available PROM programmer. The memory module fits into the adapter socket and then into a PROM programmer.

ATTENTION: Make sure the adapter is inserted properly or damage could result.

The following table lists the types of memory modules that are available for the fixed controller. Also listed are the manufacturer part number for determining compatibility with an external PROM burner.

Description	Catalog Number	Manufacturer	Manufacturer's Part Number
1K User Words EEPROM	1747–M1	NEC	uPD28C64 – 250
		OKI	MSM28C64ARS – 20
		XICOR	X28C64BP – 25
		SEEQ	PE28C64 – 250
4K User Words EEPROM	1747–M2	XICOR	X28C256DI – 25
			X28256DI – 25
		SEEQ	DE28C256 – 25
1K User Words UVPROM	1747–M3	Fujitsu	MBM27C64 – 25
4K User Words UVPROM	1747–M4	Not compatible with the fixed controller.	
Adaptor Socket	1747–M5	NA	NA

Selecting Isolation Transformers

If there is high frequency conducted noise in or around your distribution equipment, we recommend that you use an isolation transformer in the AC line to the power supply. This type of transformer provides isolation from your power distribution system and is often used as a "step down" transformer to reduce line voltage. Any transformer used with the controller must have a sufficient power rating for its load. This power rating is generally expressed in voltamperes (VA).

To select an appropriate isolation transformer, you must calculate the power required by the fixed I//O chassis and any input circuits and output loads that are connected through this transformer. The power requirement of any fixed I/O unit is 50 VA.

The power requirement for the input circuits is determined by the number of inputs, the operating voltage, and the nominal input current. The power requirement for output loads is determined by the number of outputs, the load voltage, and load current.

For example, if you have a 1747–L30B fixed unit with 18 AC inputs (12mA at 120 VAC) and 12 triac outputs (0.5A at 120 VAC), the power consumed would be:

$$50 + (18)(120)(0\ 012) + (12)(120)(0.5) = 796\ \text{VA}$$

Important: In this case, 0.5 Amp is the maximum rating of the triac output (at +30° C). If your load draws less than 0.5 Amp, this figure may be reduced accordingly. The output portion of the VA calculation should reflect the current requirements of your loads.

In general, we recommend that the transformer is oversized to provide some margin for line voltage variations and other factors. Typically a transformer that is 25% larger than the calculated VA is sufficient.

Special Considerations

The recommendations given previously provide favorable operating conditions for most controller installations. Your application may involve one or more of the following adverse conditions. Additional measures can be taken to minimize the effect of these conditions.

Excessive Line Voltage Variations

The best solution for excessive line voltage variation is to correct any feeder problems in your distribution system. Where this does not solve the line variation problem, or in certain critical applications, use a constant voltage transformer. If you require a constant voltage transformer, connect it to the power supply *and* all input devices connected to the SLC 500 controller.

Connect output devices on the same power line, but their connection along the power line is normally made before the constant voltage transformer. A constant voltage transformer must have a sufficient power rating for its load.

Excessive Noise

When you operate the SLC 500 controller in a "noise polluted" industrial environment, special consideration should be given to possible electrical interference.

The following reduces the effect of electrical interference:

- SLC 500 controller design features
- proper mounting of controller within an enclosure
- proper equipment grounding
- proper routing of wiring
- proper suppression added to noise generating devices

Potential noise generators include inductive loads, such as relays, solenoids, and motor starters when operated by "hard contacts" like push buttons or selector switches. Suppression may be necessary when such loads are connected as output devices or when connected to the same supply line that powers the controller.

Lack of surge suppression on inductive loads may attribute to processor faults and sporadic operation, RAM memory can be corrupted (lost) and I/O modules may appear to be faulty or reset themselves.

For extremely noisy environments, use a memory module and program it for auto loading on processor fault or power cycle for quick recovery.

Selecting Surge Suppressors

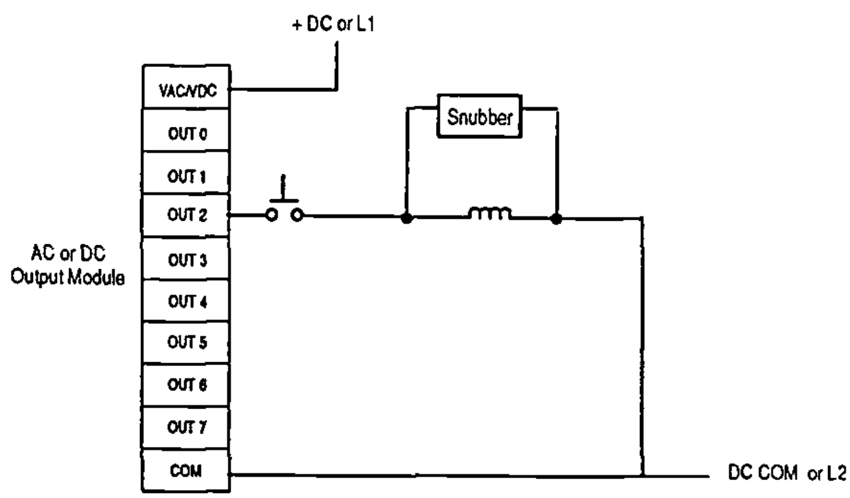
Most output modules have built–in surge suppression to reduce the effects of high voltage transients. However, we recommend that you use an additional suppression device if an output module is being used to control an inductive device such as:

- relays
- solenoids
- motor starters
- motors

Additional suppression is especially important if your inductive device is in series with or parallel to a hard contact such as:

- pushbuttons
- selector switches

By adding a suppression device directly across the coil of an inductive device, you will reduce the effects of voltage transients caused by interrupting the current to that inductive device and prolong the life of the switch contacts. The diagram below shows an output module with a suppression device.



If you connect an SLC 500 controller triac output to control an inductive load, we recommend that you use varistors to suppress noise. Choose a varistor that is appropriate for the application. The surge suppression we recommend for triac outputs when switching 120 VAC inductive loads is Harris MOV, part number V220 MA2A. For a 509 motor starter, use a 599–K04 or 599–KA04 series C or later MOV with triac outputs.

Consult the varistor manufacturer's data sheet when selecting a varistor for your application.

ATTENTION: Damage could occur to SLC 500 triac outputs if you use suppressors having RC networks. Allen–Bradley AC surge suppressors *not recommended* for use with triacs include Catalog Numbers 199–FSMA1, 199–FSMA2, 1401–N10, and 700–N24.

Allen–Bradley surge suppressors recommended for use with Allen–Bradley relays, contactors, and starters are shown in the table below.

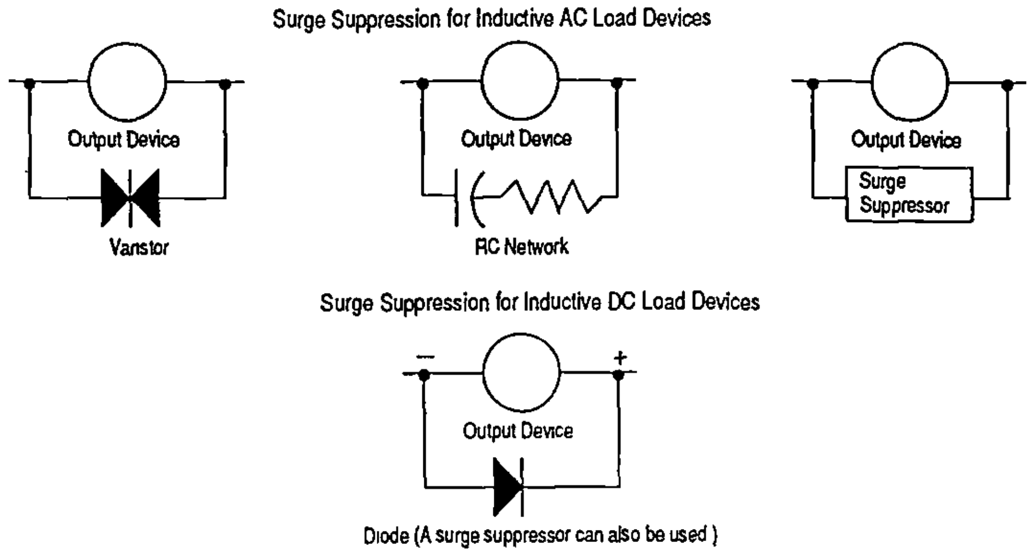
Device	Coil Voltage	Suppressor Catalog Number
Bulletin 509 Motor Starter Bulletin 509 Motor Starter	120 VAC 240 VAC	599–K04① 599–KA04①
Bulletin 100 Contactor Bulletin 100 Contactor	120 VAC 240 VAC	199–FSMA1② 199–F5MA2②
Bulletin 709 Motor Starter	120 VAC	1401–N10②
Bulletin 700 Type R, RM Relays	AC coil	None Required
Bulletin 700 Type R Relay Bulletin 700 Type RM Relay	12 VDC 12 VDC	700–N22 700–N28
Bulletin 700 Type R Relay Bulletin 700 Type RM Relay	24 VDC 24 VDC	700–N10 700–N13
Bulletin 700 Type R Relay Bulletin 700 Type RM Relay	48 VDC 48 VDC	700–N16 700–N17
Bulletin 700 Type R Relay Bulletin 700 Type RM Relay	115–125 VDC 115–125 VDC	700–N11 700–N14
Bulletin 700 Type R Relay Bulletin 700 Type RM Relay	230–250 VDC 230–250 VDC	700–N12 700–N15
Bulletin 700 Type N, P, or PK Relay	150V max, AC or DC	700–N24②
Miscellaneous electromagnetic devices limited to 35 sealed VA		

① *This is an MOV without a capacitor. The 599–K04 or 599–KA04 MOV must be series C or later when used with triac outputs. Do not use series A or B with triac outputs*

② *Not recommended for use with triac outputs*

Selecting Contact Protection

Inductive load devices such as motor starters and solenoids may require the use of some type of surge suppression to protect the controller output contacts. Switching inductive loads without surge suppression can *significantly* reduce lifetime of relay contacts. The figure below shows the use of surge suppression devices.



Contact Protection Methods for Inductive AC and DC Output Devices

These surge suppression circuits connect directly across the load device. This reduces arcing of the output contacts. Suitable surge suppression methods for inductive AC load devices include a varistor, an RC network, or an Allen-Bradley surge suppressor. These components must be appropriately rated to suppress the switching transient characteristic of the particular inductive device.

For inductive DC load devices, a diode is suitable. A 1N4004 diode is acceptable for most applications. A surge suppressor can also be used. See table on page 1–15.

We recommend that you locate the suppression device as close as possible to the load device.

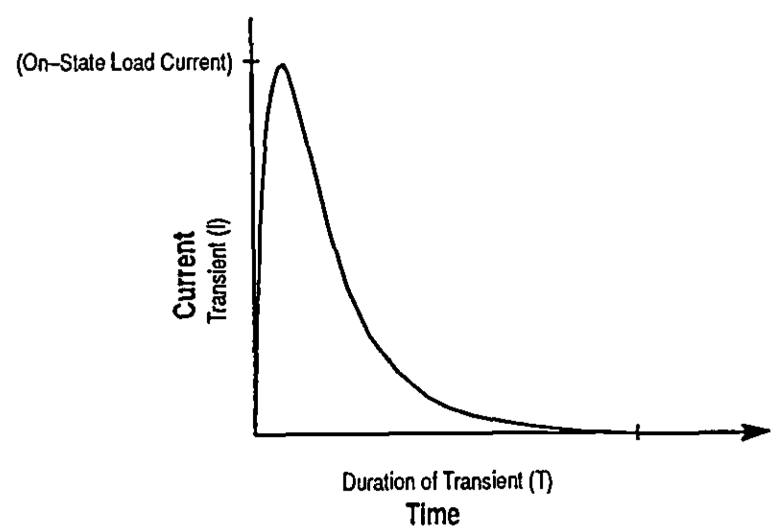
Transistor Output Transient Pulses

This section applies to the following SLC 500 Fixed I/O processors and SLC 500 I/O modules that have transistor outputs.

Fixed I/O Processors	I/O Modules
1747–L20E	1746–OB8
1747–L20G	1746–OV8
1747–L20L	1746–OB16
1747–L20N	1746–OBP16
1747–L30L	1746–OV16
1747–L40E	1746–OB32
1747–L40L	1746–OV32

For the SLC 500 products listed above, the maximum duration of the transient pulse occurs when minimum load is connected to the output. However, for most applications the energy of the transient pulse is not sufficient to energize the load.

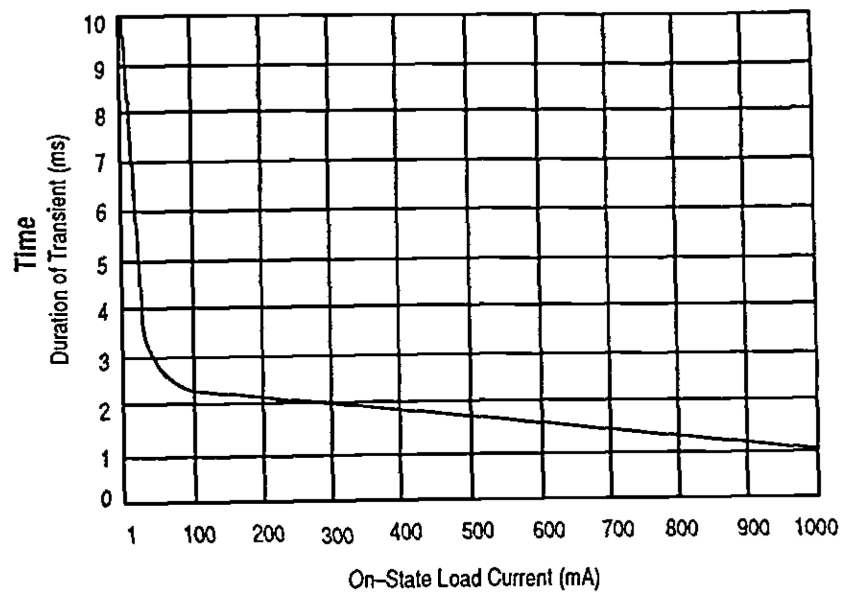
ATTENTION: A transient pulse occurs in transistor outputs when the external DC supply voltage is applied to the common output terminals (e.g., via the master control relay). The sudden application of voltage creates this transient pulse. (See the following graph.) This condition is inherent in transistor outputs and is common to solid state devices. A transient pulse can occur regardless of the processor having power or not.



To reduce the possibility of inadvertent operation of devices connected to transistor outputs, adhere to the following guidelines:

- Either ensure that any programmable device connected to the transistor output is programmed to ignore all output signals until after the transient pulse has ended,
- or add an external resistor in parallel to the load to increase the on-state load current. The duration of the transient pulse is reduced when the on-state load current is increased.

The duration of the transient pulse is proportional to the load impedance. This is illustrated in the following graph.



Example

Increasing the load current by 100mA decreases the transient time from approximately 7 ms to less than 2.5 ms. To calculate the size of the resistor added in parallel to increase the current, use the following information:

24V = your applied voltage

Need 100mA of load current to reduce the transient to < 2.5 ms. (taken from graph on previous page)

$$R\ (\text{Ohms}) = \frac{V\ (\text{Volts})}{I\ (\text{Amps})}$$

Resistor value (Ohms) = Applied voltage (Volts) / Desired current (Amps)
= 24 / 0.1
= 240 (Ohms)

P (Watts) = I^2 (Amps) x R (Ohms)

Actual Power (Watts) = $(\text{Desired Current})^2$ x Resistor Value
= $(0.1)^2$ x 240
= 2.4 (Watts)

Resistor size = 2 x Actual power (Watts)
= 2 x 2.4
= 4.8 (Watts)

Round resistor size to 5 Watts.

You need a resistor rated for 240 Ohms at 5 Watts to increase the load current by 100mA; thus decreasing the transient time from approximately 7 ms to less than 2.5 ms.

685 463

Chapter 2

System Installation Recommendations

To help you install the SLC 500 programmable controller as safely and securely as possible, we have set up a few specific recommendations for you to follow.

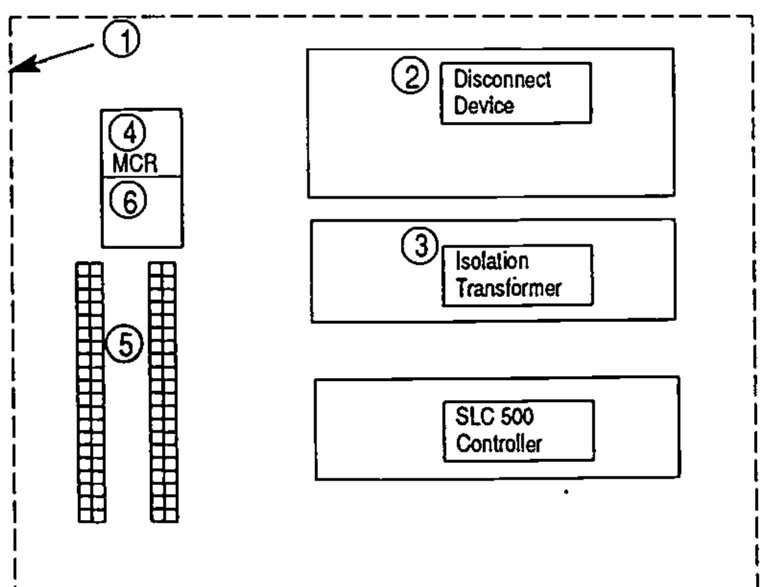
For general installation guidelines, also refer to article 70E of the National Fire Protection Association (NFPA). Article 70E describes electrical safety requirements for employee workplaces. This chapter covers the following:

- typical installation
- spacing your controllers
- preventing excessive heat
- grounding guidelines
- master control relay
- power considerations
- safety considerations
- preventative maintenance

Typical Installation

The figure below consists of some components that make up a typical installation. The following symbols are used:

1. NEMA rated enclosure suitable for your application and environment that shields your controller from electrical noise and airborne contaminants.
2. Disconnect, to remove power from the system
3. Fused isolation transformer or a constant voltage transformer, as your application requires
4. Master control relay/emergency stop circuit
5. Terminal blocks or wiring ducts
6. Suppression devices for limiting EMI (electromagnetic interference) generation

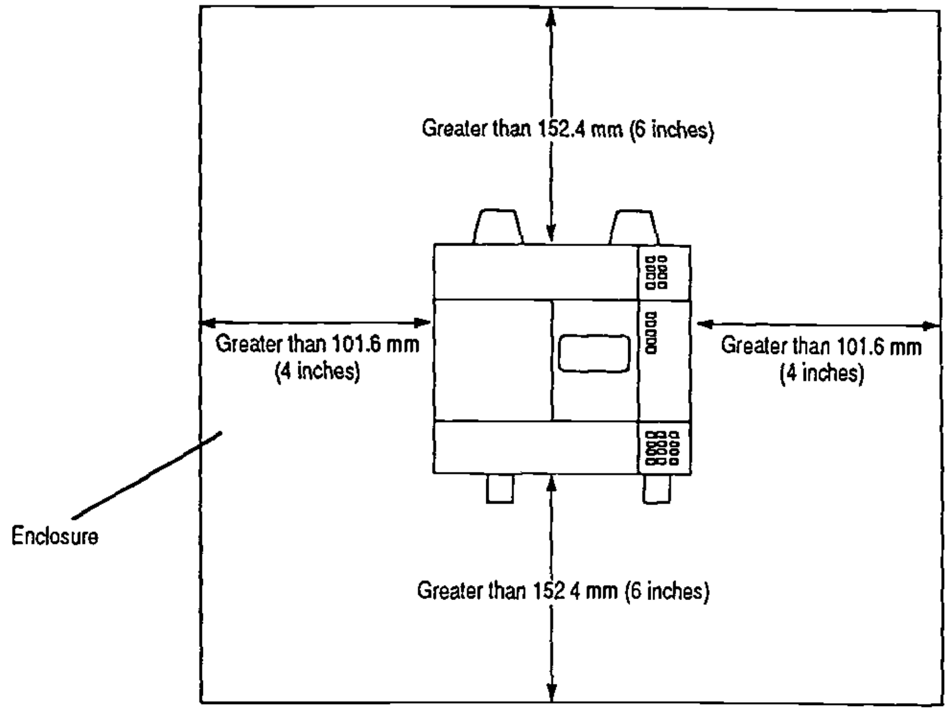


685 464

Spacing Your Components

Follow the recommended minimum spacing shown below to allow for convection cooling within the enclosure. Air in the enclosure must be kept within a range of 0° to +60° C (+32° to +140° F).

Important: Be careful of metal chips when drilling mounting holes for the controllers. Do not drill holes above a mounted SLC 500 controller. Metal chips or clippings may short circuit electronic components of the controller and cause intermittent or permanent malfunction.



Preventing Excessive Heat

For most applications, normal convection cooling will keep the controller components within the specified operating range. Proper spacing of components within the enclosure is usually sufficient for heat dissipation.

In some applications, a substantial amount of heat is produced by other equipment inside or outside the enclosure. In this case, place blower fans inside the enclosure to assist in air circulation and to reduce "hot spots" near the controller.

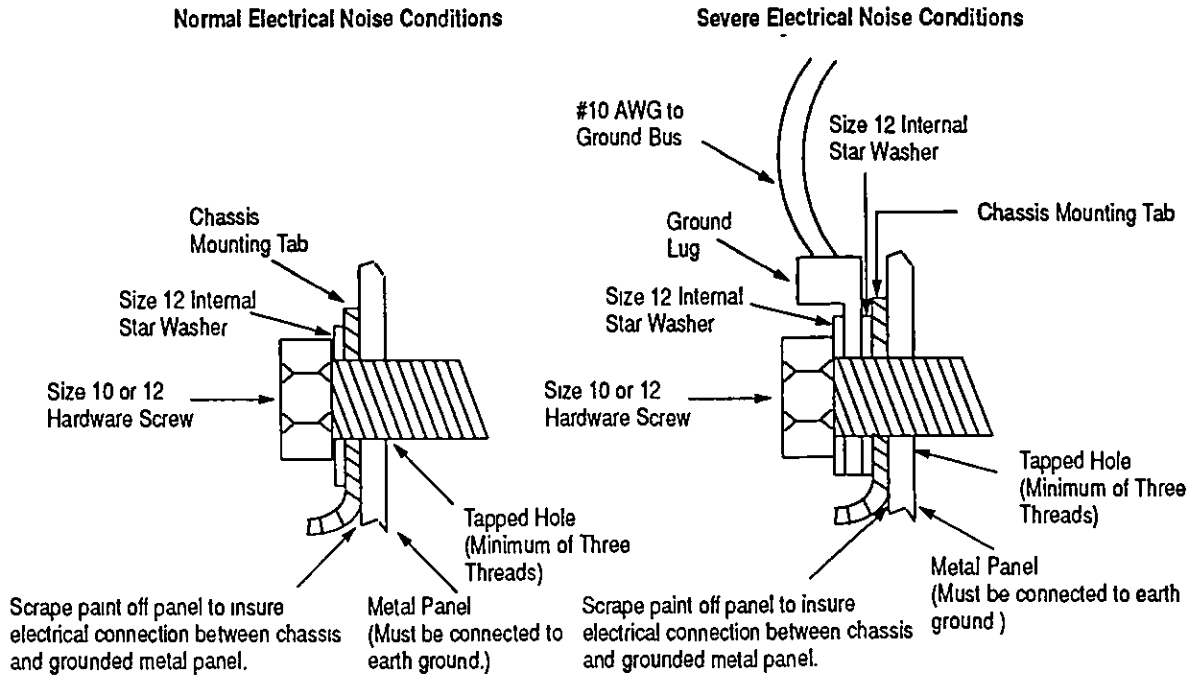
Additional cooling provisions might be necessary when high ambient temperatures are encountered.

Important: Do not bring in unfiltered outside air. It may introduce harmful contaminants of dirt that could cause improper operation or damage to components. In extreme cases, you may need to use air conditioning to protect against heat build–up within the enclosure.

685 465

Grounding Guidelines

In solid–state control systems, grounding helps limit the effects of noise due to electromagnetic interference (EMI). The grounding path for the controller and its enclosure is provided by the equipment grounding conductor.



ATTENTION: The SLC 500 controller, other control devices, and the enclosure must be properly grounded. All applicable codes and ordinances must be observed when wiring the controller system.

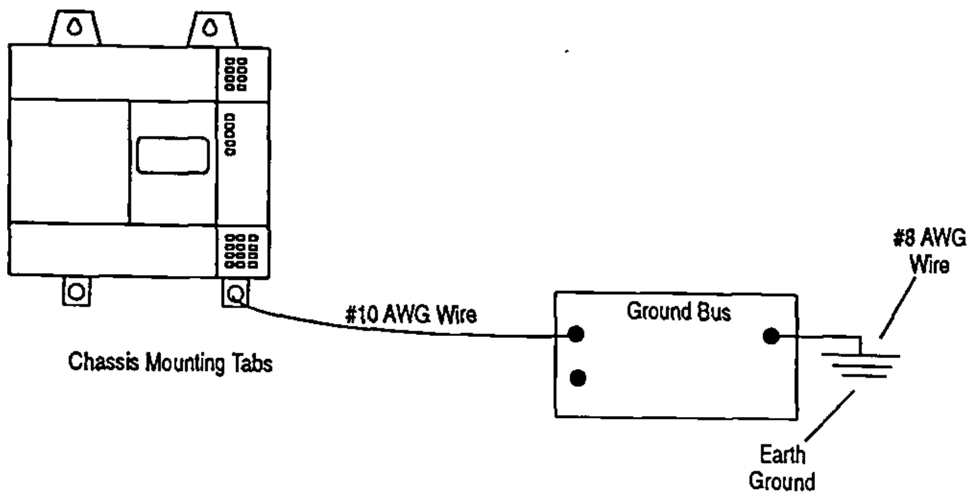
Ground connections should run from the chassis and power supply on each controller and expansion unit to the ground bus. Exact connections will differ between applications. An authoritative source on grounding requirements for most installations is the National Electrical Code. Also, refer to *Allen–Bradley Programmable Controller Grounding and Wiring Guidelines*, Publication Number 1770–4.1.

In addition to the grounding required for the controller and its enclosure, you must also provide proper grounding for all controlled devices in your application. Care must be taken to provide each device with an acceptable grounding path.

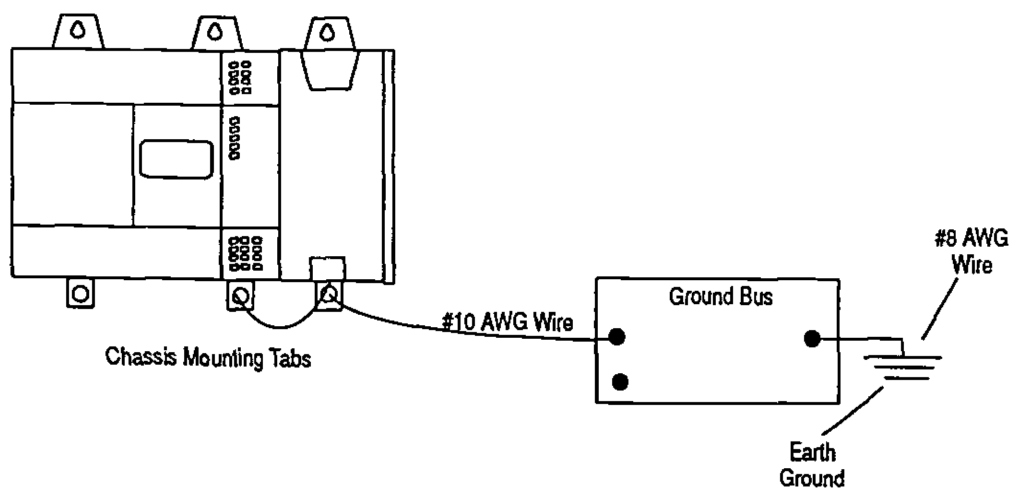
685 466

The figure below shows you how to run ground connections from the chassis to the ground bus.

SLC 500 Controller Only



SLC 500 Controller with 2–slot Expansion Chassis



Master Control Relay

A hard–wired master control relay (MCR) provides a convenient means for emergency controller shutdown. Since the master control relay allows the placement of several emergency–stop switches in different locations, its installation is important from a safety standpoint. Overtravel limit switches or mushroom head push buttons are wired in series so that when any of them opens, the master control relay is de–energized. This removes power to input and output device circuits. Refer to the figure on page 2–6.

ATTENTION: Never alter these circuits to defeat their function, since serious injury and/or machine damage could result.

Important: If you are using a DC output power supply, interrupt the output side rather than the AC line to avoid the additional delay of power supply turn–on and turn–off. The power supply should receive its power directly from the fused secondary of the transformer. Connect the power to the DC input and output circuits through a set of master control relay contacts.

Place the main power disconnect switch where operators and maintenance personnel have quick and easy access to it. If you mount a disconnect switch inside the controller enclosure, place the switch operating handle on the outside of the enclosure, so that you can disconnect power without openin the enclosure.

Whenever any of the emergency–stop switches are opened, power to input and output devices is stopped.

When you use the master control relay to remove power from the external I/O circuits, power continues to be provided to the controller's power supply so that diagnostic indicators on the processor can still be observed.

The master control relay is not a substitute for a disconnect to the controller. It is intended for any situation where the operator must quickly de–energize I/O devices only. When inspecting or installing terminal connections, replacing output fuses, or working on equipment within the enclosure, use the disconnect to shut off power to the rest of the system.

Important: The operator must not control the master control relay with the SLC 500 controller. Provide the operator with the safety of a direct connection between an emergency–stop switch and the master control relay.

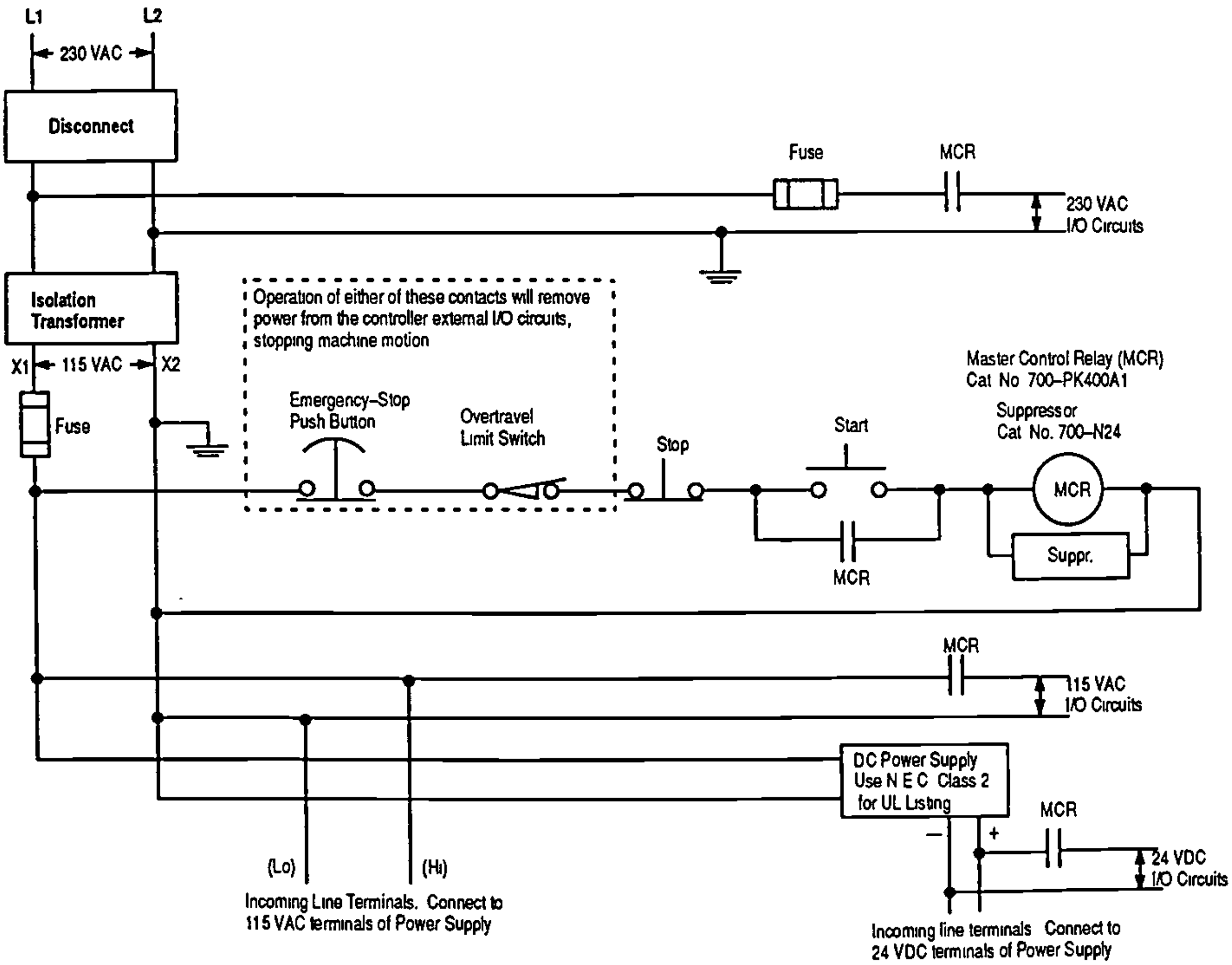
685 468

Emergency-Stop Switches

Adhere to the following points concerning emergency–stop switches:

- Do not program emergency–stop switches in the controller program. Any emergency–stop switch should turn off all machine power by turning off the master control relay.
- Observe all applicable local codes concerning the placement and labeling of emergency–stop switches.
- Install emergency–stop switches and the master control relay in your system. Make certain that relay contacts have a sufficient rating for your application. Emergency–stop switches must be easy to reach.

The figure below shows the Master Control Relay Wired in Grounded System.



Power Considerations

The following explains power considerations for the SLC 500 fixed controller.

Common Power Source

We strongly recommend that the chassis power supply has the same power source as the input and output devices. This helps:

- reduce the chance of electrical interference due to multiple sources and grounds
- maintain system integrity if power is interrupted

Loss of Power Source

The chassis power supply is designed to withstand brief power losses without affecting the operation of the system. The time the system is operational during power loss is called "program scan hold–up time after loss of power." The duration of the power supply hold–up time depends on the number, type and state of the I/O, but is typically between 20 ms and 700 ms. When the duration of power loss reaches a limit, the power supply signals the processor that it can no longer provide adequate DC power to the system. This is referred to as a power supply shutdown. The POWER LED is turned off.

Input States on Power Down

The power supply hold–up time as described above is generally longer than the turn–on and turn–off times of the input circuits. Because of this, the input state change from "On" to "Off" that occurs when power is removed may be recorded by the processor before the power supply shuts down the system. Understanding this concept is important. The user program should be written to take this effect into account. For example, hard wire power to one spare input. In the user program, check to be sure that one input is on; otherwise, jump to the end of the program and avoid scanning the logic. Use of a common power source as recommended in the previous section is assumed.

Other Types of Line Conditions

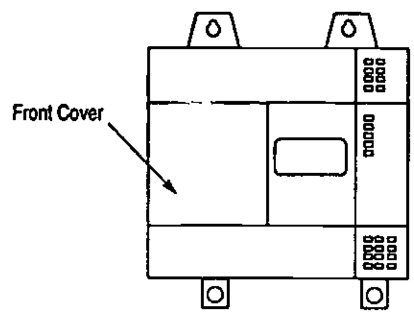
Occasionally the power source to the system can be temporarily interrupted. It is also possible that the voltage level drops substantially below the normal line voltage range for a period of time. Both of these conditions are considered to be a loss of power for the system.

685 470

Safety Considerations

Safety considerations are an important element of proper system installation. Actively thinking about the safety of yourself and others, as well as the condition of your equipment, is of primary importance. Several safety areas are discussed below.

High Voltages – SLC 500 Fixed Hardware Style Controller (Series C) (Applies to 1747–L20A, –L30A, –L40A, –L20C, –L30C, and –L40C controllers)



ATTENTION: The printed circuit board, located under the front cover of Series C Fixed Hardware Style Controllers, has high voltages (120 VAC and 240 VAC) available at certain points when the controller is powered up. If the front cover is removed, exercise extreme care and consider all points on the circuit board to be electrically hazardous. Therefore, whenever possible, turn off power to the controller before removing the front cover. *Do not* remove the protective insulation covering the circuit board. Cutouts in the insulation are provided to allow access to the high–speed counter jumper, memory module, and battery connector. If the insulation is missing, do not touch any portion of the circuit board. Failure to heed this warning may result in personal injury or death.

Disconnecting Main Power

The main power disconnect switch should be located where operators and maintenance personnel have quick and easy access to it. Ideally, the disconnect switch is mounted on the outside of the enclosure, so that it can be accessed without opening the enclosure. In addition to disconnecting electrical power, all other sources of power (pneumatic and hydraulic) should be de–energized before working on a machine or process controlled by an SLC controller.

Preventive Maintenance

The printed circuit boards of the controller must be protected from dirt, oil, moisture, and other airborne contaminants. To protect these boards, the controller must be installed in an enclosure suitable for the environment. The interior of the enclosure should be kept clean and the enclosure door should be kept closed whenever possible.

Regularly inspect your terminal connections for tightness. Loose connections may cause improper functioning of the controller or damage the components of the system.

ATTENTION: To ensure personal safety and to guard against damaging equipment, inspect connections with incoming power off.

The National Fire Protection Association (NFPA) provides recommendations for electrical equipment maintenance. Refer to article 70B of the NFPA for general requirements regarding safety related work practices.

Chapter 3

Mounting Your SLC 500 Control System

This chapter provides you with mounting dimensions for the following SLC 500 components:

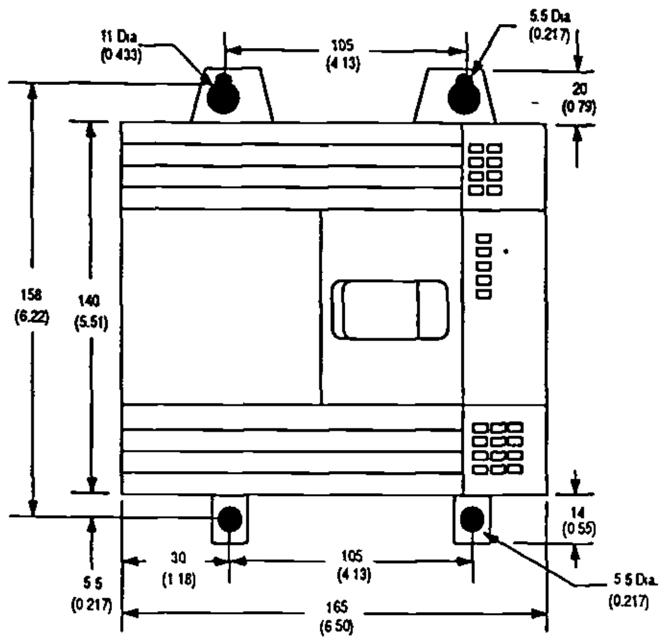
- 20 I/O fixed controller
- 30 & 40 I/O fixed controller
- 2–slot expansion chassis
- link coupler (AIC)
- Data Table Access Module (DTAM)

Mounting Fixed Hardware Style Units

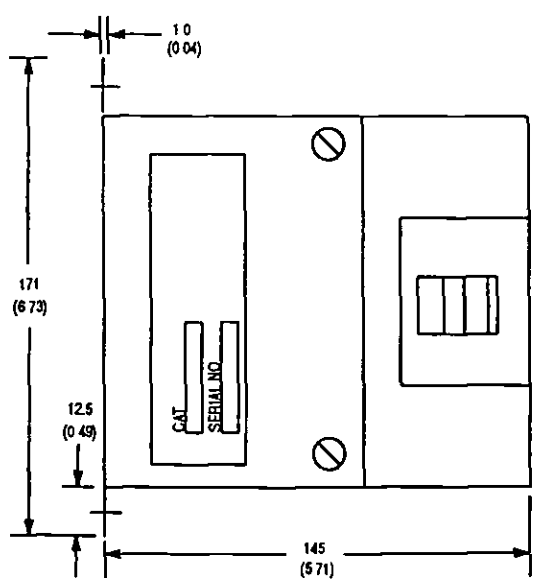
You can mount the fixed hardware style units directly to the back panel of your enclosure using the mounting tabs and #10 and #12 screws. The torque requirement is 3.4 N–m (30 in–lbs) maximum. Dimensions are in millimeters. (Dimensions in parentheses are in inches.)

685 473

20 I/O Fixed Controller①



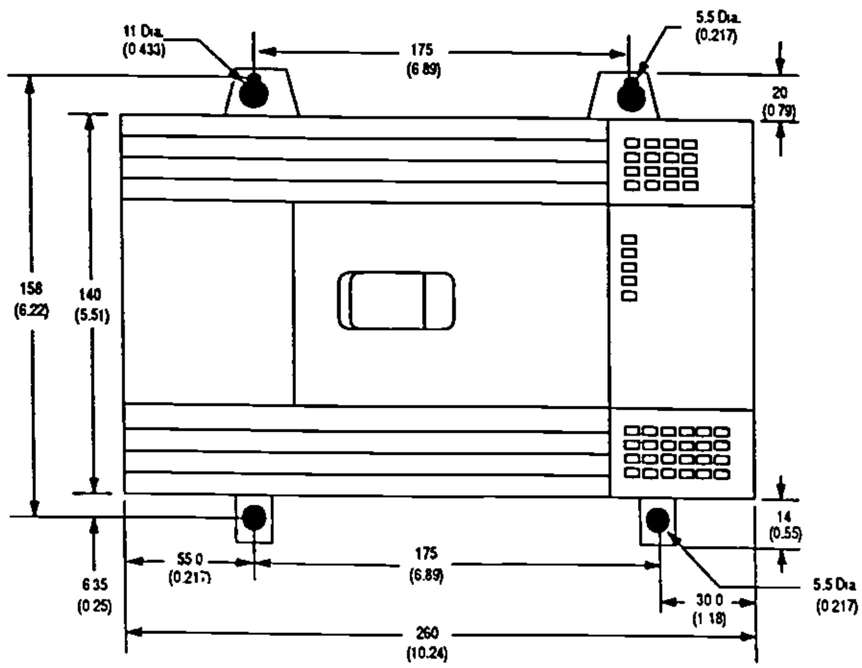
Front View



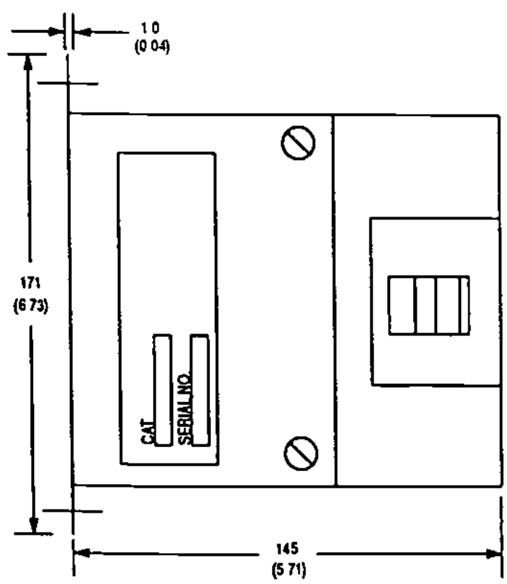
Left Side View

① *Dimensions are in millimeters (Dimensions in parentheses are in inches.)*

30 and 40 I/O Fixed Controller[1]



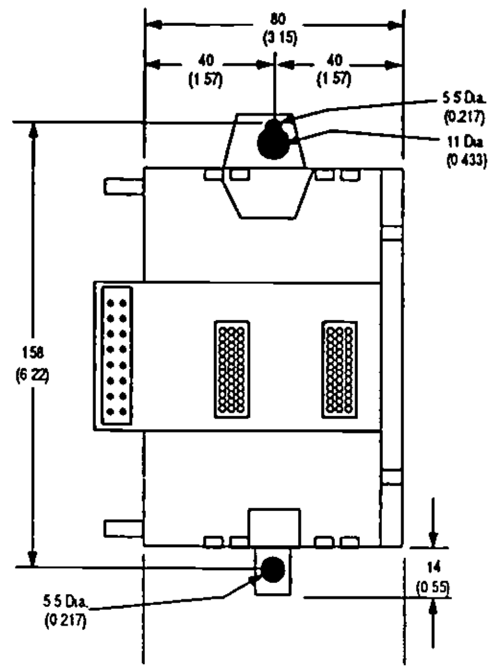
Front View



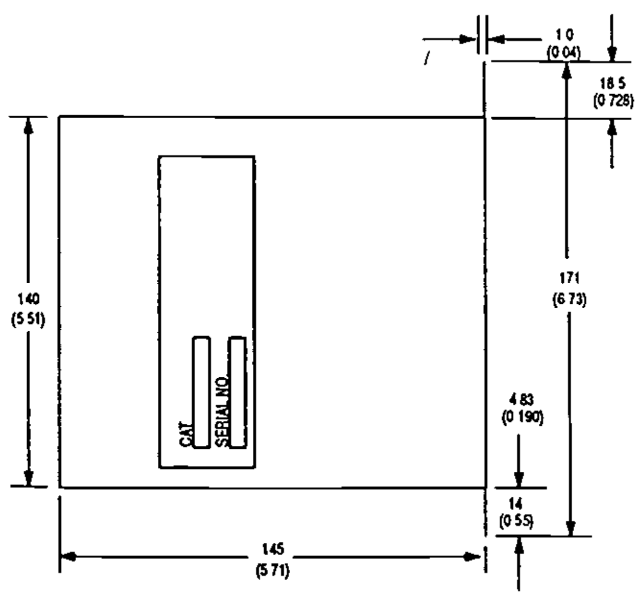
Left Side View

[1] *Dimensions are in millimeters (Dimensions in parentheses are in inches.)*

2–Slot Expansion Chassis[1]



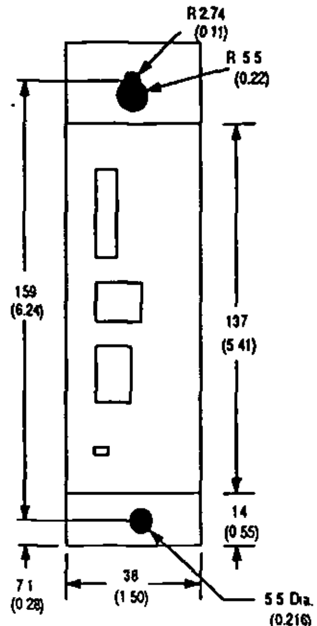
Front View



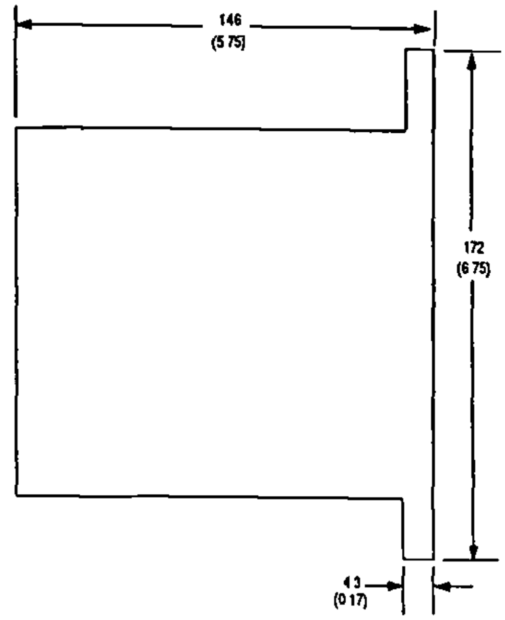
Right Side View

[1] *Dimensions are in millimeters. (Dimensions in parentheses are in inches.)*

Link Coupler (AIC)①

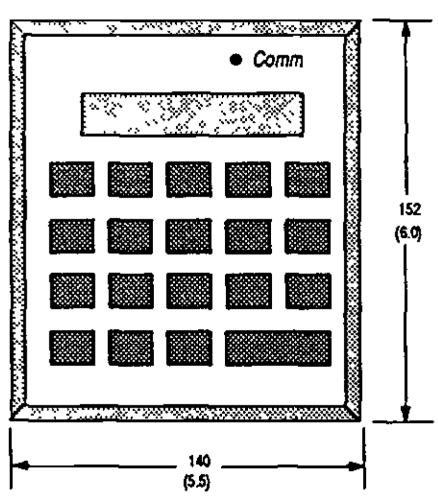


Front View

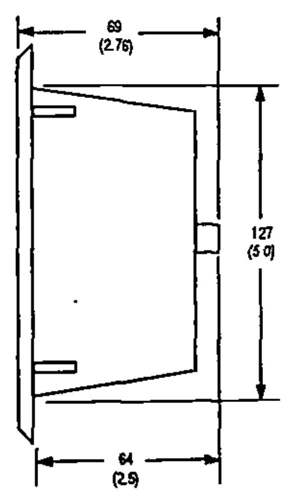


Right Side View

Data Table Access Module (DTAM)①



Front View



Right Side View

① *Dimensions are in millimeters (Dimensions in parentheses are in inches.)*

685 477

Chapter 4

Installing Your Hardware Components

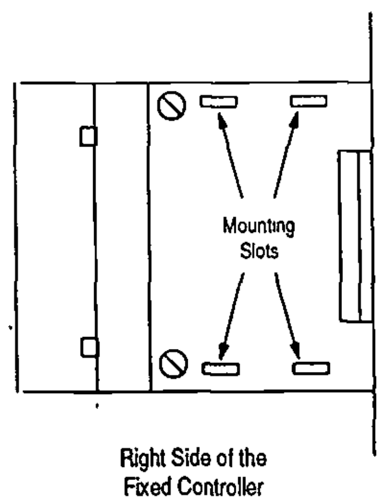
This chapter shows you how to install and remove the following hardware components:

- 2–slot expansion chassis
- I/O and speciality modules
- memory module
- high–speed counter

Mounting the 2–Slot Expansion Chassis

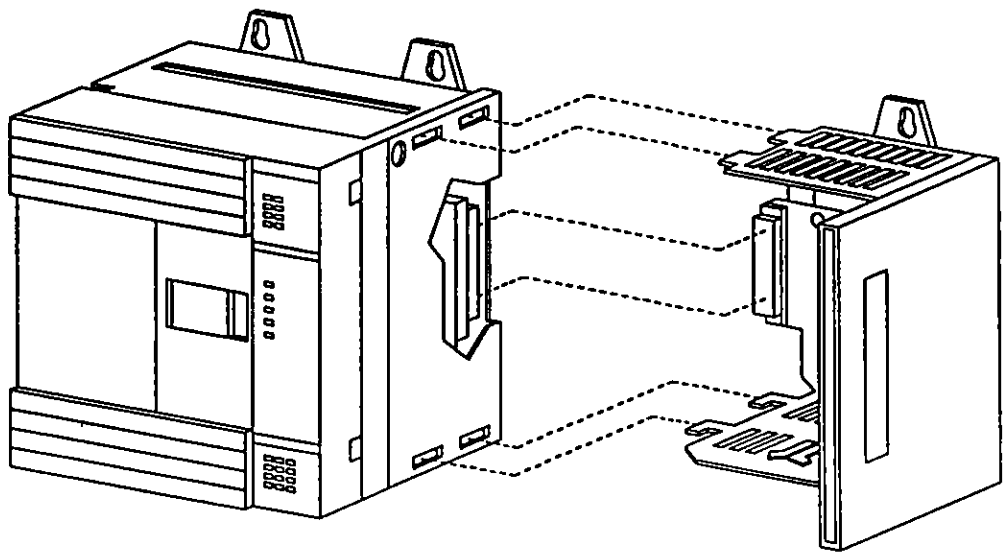
The expansion chassis mounts on the right side of the fixed controller. The chassis has mounting tabs that are inserted into slots in the fixed controller and slid forward. No tools are required.

1. Insert the mounting tabs of the expansion chassis into the mounting slots of the controller.



685 478

2. Slide the expansion chassis forward until the back of the expansion chassis is flush with the fixed controller and the connector on the expansion circuit board is mated with the connector in the controller.



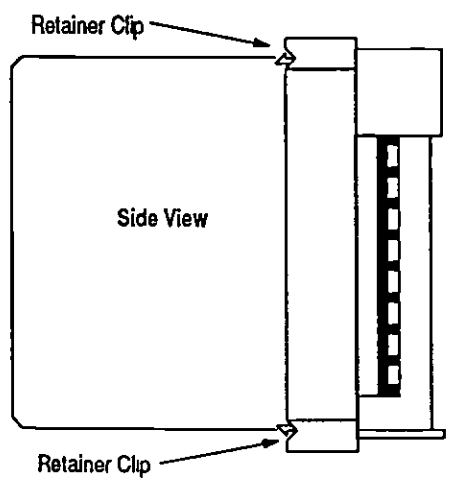
19528

Installing I/O and Speciality Modules

With the 2–slot expansion chassis on the fixed style unit, additional I/O and specialty modules can be supported.

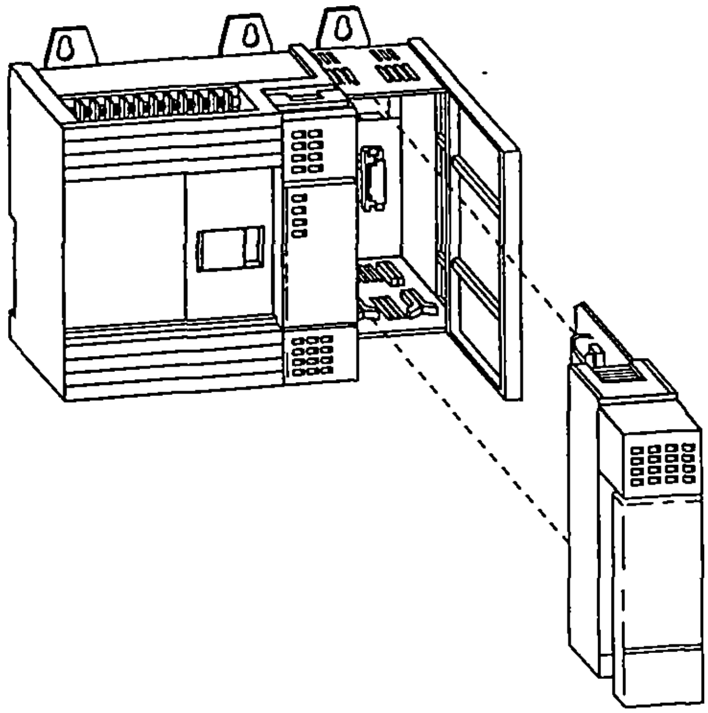
ATTENTION: Never install, remove, or wire modules with power applied to the chassis.

1. Align circuit board of the module with card guide in chassis.



685 479

2. Gently slide the module in until both top and bottom retainer clips are secured.



3. To remove the module, press the retaining clips at the top and bottom of the module and slide the module out.

685 480

Installing Your Memory Module

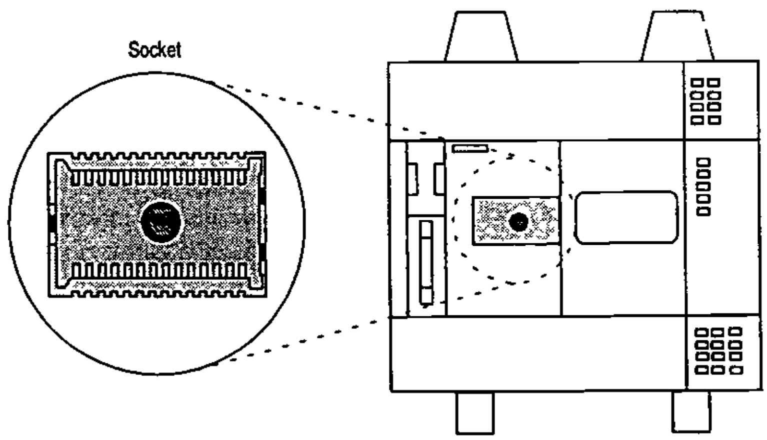
Always turn off power to the controller before inserting or removing the memory module. This guards against possible damage to the module and also undesired processor faults. Memory modules are mounted in carriers and have connectors that are "keyed" to guard against improper installation.

ATTENTION: To avoid potential damage to the memory modules, handle them by the ends of the carrier or edges of the plastic housing. Skin oil and dirt can corrode metallic surfaces, inhibiting electrical contact. Also, do not expose memory modules to surfaces or areas that may hold an electrostatic charge. Electrostatic charges can alter or destroy memory.

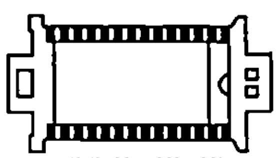
1. Always turn off power to the controller before inserting or removing the memory module. This guards against possible damage to the module and also undesired processor faults.

ATTENTION: When power is applied to the controller hazardous electrical potentials exist under the front cover. See page 2–8 for more information.

2. Remove the processor compartment cover.
3. Locate the socket on the PC board.



4. Position the module correctly over the socket a d press it firmly in place. (The memory module is keyed.)



5. Replace the cover on the SLC controller and restore power.

685·481

Removing Your Memory Module

To remove a memory module use the following procedure:

1. Remove the power from the fixed I/O unit.
2. Remove the processor compartment cover.
3. Grasp the carrier tabs with the thumb and index fingers, then gently but firmly lift upwards on either end of the memory module carrier.
4. When the end is partially raised, begin lifting the other end in the same manner. Repeat this until the memory module has been completely removed from the socket.
5. Replace processor cover.

Using the High–Speed Counter

The fixed I/O units that have 24 VDC input circuits are also equipped with a high–speed counter. The counter is capable of counting at a rate of up to 8 kHz.

You have the option of using input 0 as a normal input or as a high–speed counter. To accommodate this dual function the input is equipped with a jumper selectable filter. You must cut the jumper for high–speed counter use. A shielded cable is recommended to reduce noise to the input.

High–Speed Counter Operation

For high–speed counter operation do the following:

1. Turn off power to the fixed controller.

ATTENTION: When power is applied to the controller hazardous electrical potentials exist under the front cover. See page 2–8 for more information.

2. Remove the SLC 500 cover.
3. Locate and cut jumper wire J2. The jumper is either beneath or to the right of the battery connector, as shown below. Do not remove completely but make certain that the ends of the cut jumper wire are not touching each other.

High–Speed Counter Input Compatibility

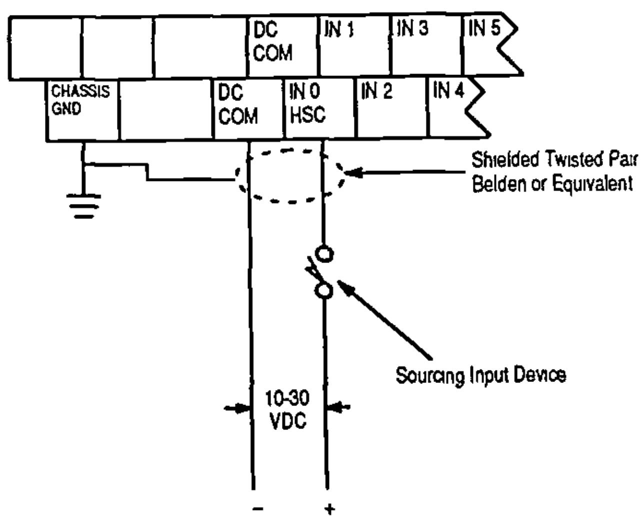
The high–speed counter input circuit has the following characteristics:

- nominal input impedance of ≈ 1200 Ω
- on–state voltage of 10–30 VDC
- nominal input current draw of 20mA
- minimum pulse width of 62.5 µsec.

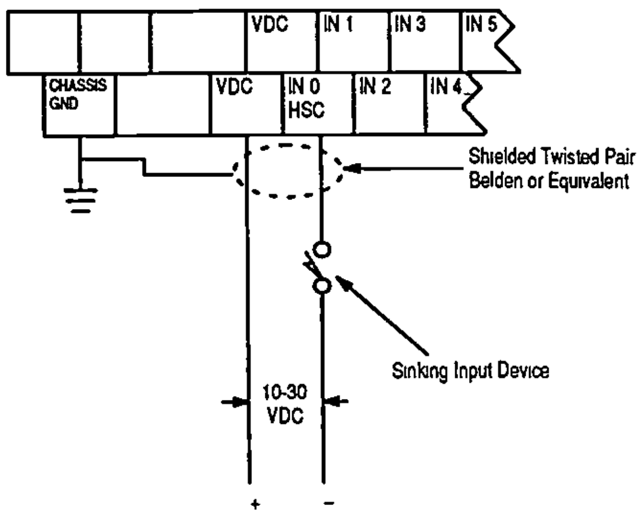
Your input device or encoder must be single–ended and be compatible with the specifications of the high–speed counter input. See the table below for more information.

For an Input Device or Encoder that Is	Use an HSC Input Circuit that Is
Sourcing	Sinking
Open Collector/ Sinking	Sourcing
Open Collector with Pull–up Resistor	Sinking

Wiring Diagram of a High–Speed Counter Sinking Input Circuit



Wiring Diagram of a High–Speed Counter Sourcing Input Circuit



Chapter 5

Wiring Your Control System

This chapter describes how to wire your I/O modules. It covers the following:

- defining sinking and sourcing
- determining approximate transient duration
- preparing your wiring layout
- features of an I/O module
- recommendations for wiring I/O devices
- wiring your I/O modules
- using Removable Terminal Blocks (RTBs)

Defining Sinking and Sourcing

Sinking and sourcing are terms used to describe a current signal flow relationship between field input and output devices in a control system and their power supply.

- Field devices connected to the positive side (+V) of the field power supply are sourcing field devices.
- Field devices connected to the negative side (DC Common) of the field power supply are called sinking field devices.

To maintain electrical compatibility between field devices and the programmable controller system, this definition is extended to the input/output circuits on the discrete I/O modules.

- Sourcing I/O circuits supply (source) current to sinking field devices.
- Sinking I/O circuits receive (sink) current from sourcing field devices.

Contact Output Circuits — AC or DC

Relays can be used for either AC or DC output circuits and accommodate either sinking or sourcing field devices. These capabilities are a result of the output switch being a mechanical contact closure, not sensitive to current flow direction and capable of accommodating a broad range of voltages.

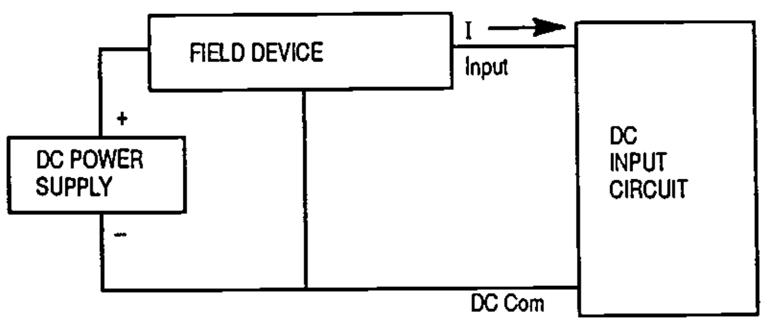
This high degree of application flexibility makes contact output modules very popular and useful in control environments with a broad mix of electrical I/O circuit requirements.

Solid-State DC I/O Circuits

The design of DC field devices typically requires that they be used in a specific sinking or sourcing circuit depending on the internal circuitry of the device.

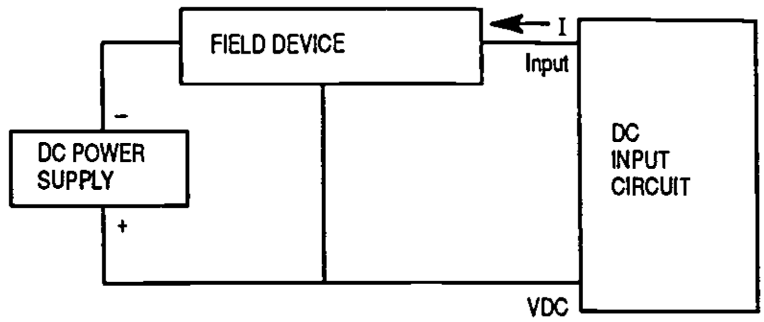
Sourcing Device with Sinking Input Module Circuit

The field device is on the positive side of the power supply between the supply and the input terminal. When the field device is activated, it sources current to the input circuit.



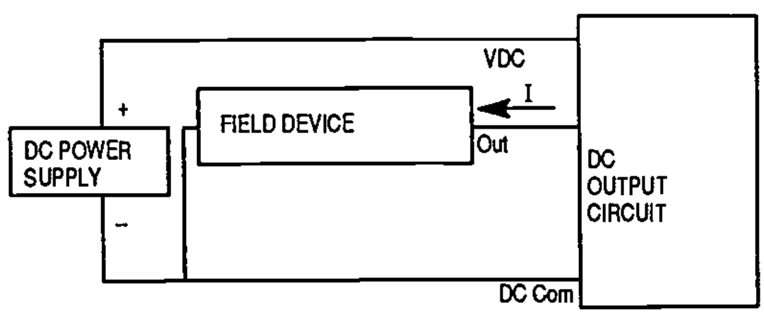
Sinking Device with Sourcing Input Module Circuit

The field device is on the negative side of the power supply between the supply and the input terminal. When the field device is activated, it sinks current from the input circuit.



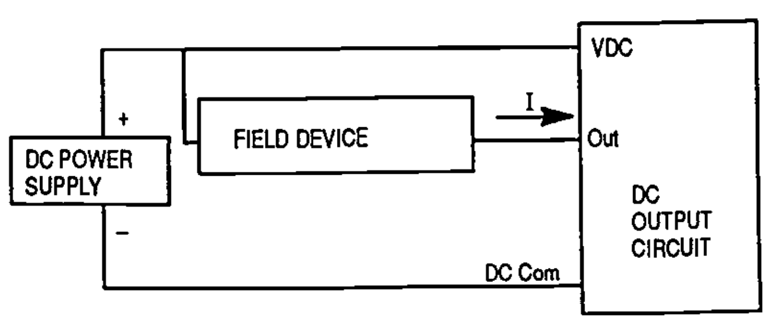
Sinking Device with Sourcing Output Module Circuit

The field device is on the negative side of the power supply between the supply and the output terminal. When the output is activated, it sources current to the field device.



Sourcing Device with Sinking Output Module Circuit

The field device is on the positive side of the power supply between the supply and the output terminal. When the output is activated, it sinks current from the field device.



685 487

Preparing Your Wiring Layout

Careful wire routing within the enclosure helps to cut down electrical noise between I/O lines. Follow these rules for routing your wires:

- Route incoming power to the controller by a separate path from wiring to I/O devices. Where paths must cross, their intersection should be perpendicular.

  Important: Do not run signal or communications wiring and power wiring in the same conduit.

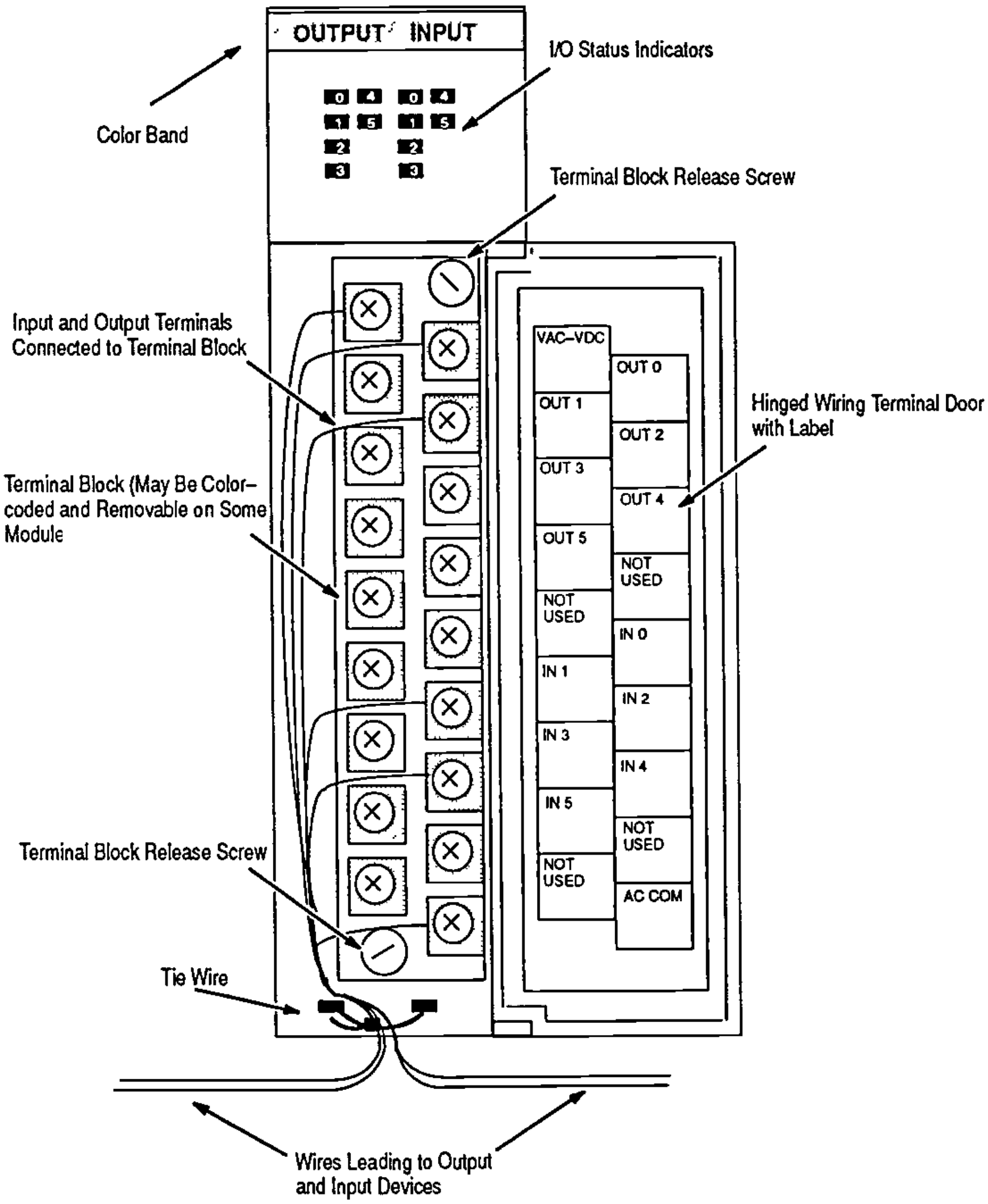
- If wiring ducts are used, allow for at least two inches between I/O wiring ducts and the controller. If the terminal strips are used for I/O wiring, allow for at least two inches between the terminal strips and the controller.
- Segregate I/O wiring by signal type. Bundle wiring with similar electrical characteristics together.

Wires with different signal characteristics should be routed into the enclosure by separate paths.

ATTENTION: If the controller is being installed within a potentially hazardous environment (that is, Class I, Division 2), all wiring must comply with the requirements stated in the National Electrical Code 501–4 (b).

Features of an I/O Module

Below is an example of a combination I/O module.



Recommendations for Wiring I/O Devices

The following are general recommendations for wiring I/O devices.

ATTENTION: Before you install and wire I/O devices, disconnect power from the controller and any other source to the I/O devices.

Use acceptable wire gauge — The I/O wiring terminals are designed to accept #14 or smaller AWG stranded wires, and two wires per terminal (maximum). Maximum torque 0.9 N–m (8 in–lb).

Label wires — Label wiring to I/O devices, power sources, and ground. Use tape, shrink–tubing, or other dependable means for labeling purposes. In addition to labeling, use colored insulation to identify wiring based on signal characteristics. For example, you may use blue for DC I/O wiring and red for AC I/O wiring.

Bundle wires — Bundle wiring for each similar I/O device together. If you use ducts, allow at least 5 cm (2 in.) between the ducts and the controller so there is sufficient room to wire the devices.

Identify terminals — Terminal cover plates have a write–on area for each terminal. Use this area to identify your I/O devices. Label the Removable Terminal Block (RTB) with appropriate slot, rack (chassis) and module identification if you have not already. Refer to page 5–8 for more information.

ATTENTION: Calculate the maximum possible current in each power and common wire. Observe all local electrical codes dictating the maximum current allowable for each wire size. Current above the maximum ratings may cause wiring to overheat, which can cause damage.

Capacitors on input modules have a stored charge that can cause a non–lethal shock. Avoid mounting the controller in a position where installation or service personnel would be in danger from startle reaction.

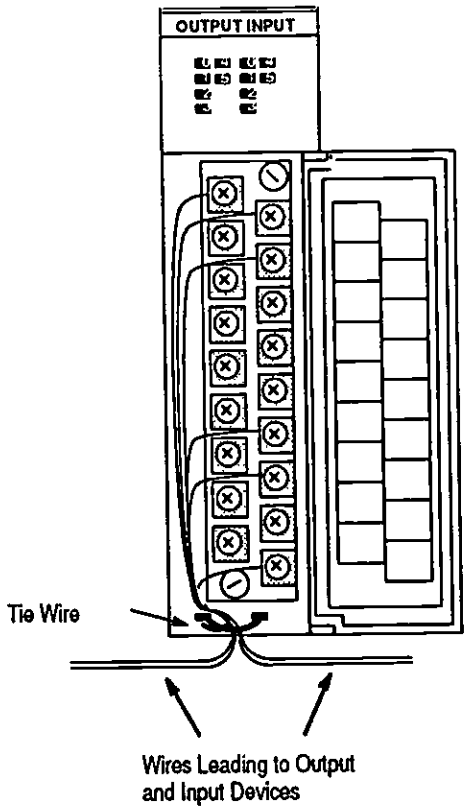
Wiring Your I/O Modules

Terminals on the modules have self-lifting pressure plates that accept two #14 AWG wires. Series B 12-point and 16-point and analog modules are equipped with removeable terminal blocks (RTBs) for ease of wiring. For more information on using RTBs, see the next section.

LED indicators on the front of each module display the status of each I/O point. The LED indicators turn on when the proper signal to an input terminal is applied or when the processor commands an output to be energized.

To locate the I/O module wiring diagrams, contact your Allen-Bradley sales office for the latest product data entitled *Discrete Input and Output Modules,* Publication Number 1746-2.35. Or, locate the installation instruction sheet that was sent with your I/O module; it also includes I/O wiring diagrams.

1. Install a wire tie to secure your wiring and keep it neat. (If you feed the tie into one hole, it will be routed back out through the other.)



2. Cover any unused slots with card slot fillers, Catalog Number 1746-N2, to keep the chassis free from debris and dust.

Using Removable Terminal Blocks (RTBs)

Removable Terminal Blocks (RTBs) are provided on all 12–point and 16–point discrete I/O modules and analog modules. RTBs can only be used with these modules in the 2–slot expansion chassis. RTBs allow for faster and more convenient wiring of the I/O modules. The modules and RTBs are color–coded as follows:

Color	Type of I/O Removable Terminal Block
Red	AC inputs/outputs
Blue	DC inputs/outputs
Orange	relay outputs
Green	specialty modules

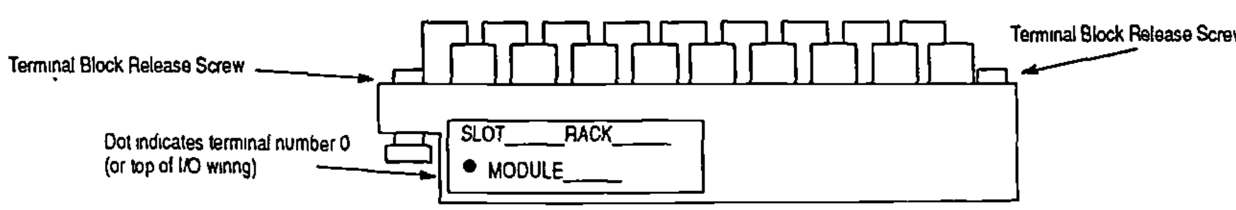
Replacement terminal blocks are available if they are lost or damaged. See the replacement part list in chapter 9.

Removing RTBs

Below are guidelines for removing the I/O RTBs.

ATTENTION: Never install or remove I/O modules or terminal blocks while the SLC is powered.

1. If the I/O module is already installed in the chassis, remove power to the SLC.
2. Unscrew the upper right and lower left terminal block release screws.
3. Grasp the RTB with your thumb and forefinger and pull straight out.
4. Label the RTB with appropriate slot, rack (chassis) and module identification.



Installing RTBs

Below are guidelines for installing the I/O RTBs.

1. Label the RTB properly.
2. Match the label identification to the correct chassis, slot, and module type.

ATTENTION: Inserting a wired RTB on an incorrect module can damage the I/O module circuitry when power is applied.

3. Be sure the color band on the I/O module matches the color of the RTB.

ATTENTION: Never install or remove I/O modules or RTBs while the SLC 500 chassis is powered.

4. Remove power from the SLC 500 chassis.
5. Line up terminal block release screws.
6. Press the RTB firmly onto connector contacts.
7. Tighten the RTB release screws.

685 493

Chapter 6

Starting Up Your Control System

This chapter describes how to start up your control system. To accomplish this, you must go through eight procedures.

Procedures for Starting Up the Control System

Start–up involves the following procedures to be carried out in sequence:

1. Inspect your installation.
2. Disconnect motion–causing devices.
3. Initialize and test your processor.
4. Test your inputs.
5. Test your outputs.
6. Enter and test your program.
7. Observe control motion.
8. Conduct a dry run of your application.

These procedures isolate problems such as wiring mistakes, equipment malfunction, and programming errors in a systematic, controlled manner.

We urge you to go through these procedures very carefully. This will help you avoid possible personal injury and equipment damage.

Important: Do not attempt system start–up until you are thoroughly familiar with the controller components and programming/editing techniques. You must also be thoroughly familiar with the particular application.

For general recommendation concerning installation safety requirements and safety requirements and safety related work practices, refer to NFPA 70E, *Electrical Safety Requirements for Employee Workplaces.*

685 494

1. Inspect Your Installation

You can often prevent serious problems in later test procedures by first making a thorough physical inspection. We recommend that you do the following:

1. Make sure that the controller and all other devices in the system are securely mounted. Refer to chapter 3 and chapter 4 for more information.
2. Check all wiring including:
   - connections from the main disconnect to the controller input
   - the master control relay/emergency-stop circuit
   - input device circuits
   - output device circuits

   Make certain that all wiring connections are correct and that there are no missing wires. Check the tightness of all terminals to make certain wires are secure. Refer to chapter 5 for more information.
3. Measure the incoming line voltage. Be certain that it corresponds to controller requirements and that it falls within the specified voltage range. See specifications for input voltage ranges in chapter 1.

2. Disconnect Motion–causing Devices

In the following test procedures, the controller will be energized. As a safety precaution, you must make certain that machine motion will not occur. The preferred way is to disconnect the motor wires at the motor starter or the motor itself. In this way, you can test the operation of the starter coil, verifying that your output circuit is wired correctly and functioning. Similarly, the preferred way to disconnect a solenoid is to disengage the valve, leaving the coil connected.

In some instances, you may not be able to disconnect a device the preferred way. In this case, it will be necessary to open the output circuit at some convenient point.

For circuit testing purposes, it is best to open the circuit at a point as close as possible to the motion–causing device. For example, your output might be a relay coil that in turn energizes a motor starter; if it is impractical to disconnect the motor wires, the next best thing to do is to open the circuit at a point between the motor starter and the relay contact.

ATTENTION: Machine motion during system checkout can be hazardous to personnel. During the checkout procedures 3, 4, 5, and 6, you must disconnect all devices that, when energized, might cause machine motion.

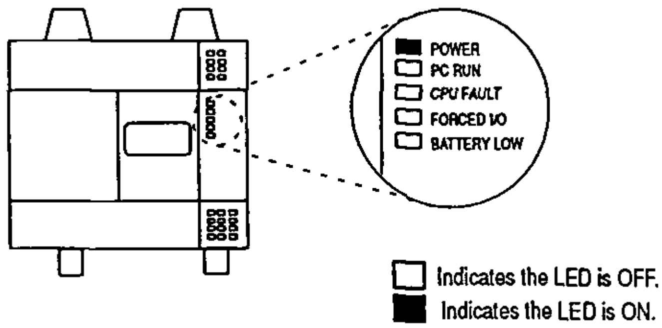
---

3. Initialize and Test Your Processor

When you are certain that machine motion cannot occur with the controller energized, you may begin by initializing the processor using the following steps:

1. Energize the controller. If power is supplied to the controller and the installation is correct, then:

   A. The POWER LED turns on as shown in the figure below.



   The CPU FAULT LED also turns on during power–up, but it should go off after a few seconds. If instead this LED starts flashing, it indicates you must clear the processor memory before continuing.

   B. The following processor initial factory conditions apply:

   - Mode = PROGRAM MODE (S:1/0 – S:1/4 = 0 0001)
   - Watchdog values = 100ms (S:3H = 0000 1010)
   - I/O Slot enables = ALL ENABLED (S:11/1 through S:12/14 set to 1)
   - Node address = 1 (S:15L = 0000 0001)
   - Baud Rate = 19.2K baud (S:15H = 0000 0100)
   - Processor Name = DEFAULT

2. Power up the programming device.

   Refer to the *Hand–Held Terminal User Manual*, Catalog Number 1747–NP002, for information on programming your fixed controller with the HHT.

   Refer to the *Advanced Programming Software User Manual*, Catalog Number 1747–NM002 Series C, and the *Advanced Programming Software Reference Manual*, Catalog Number 1747–NR001, for information on programming your fixed controller with APS.

3. Configure the controller.
4. Name the processor file.
5. Program a sample test rung not affecting machine operation.
6. Save the program and the controller configuration.

7. Transfer the controller configuration and the sample test program to the processor. After the new program is transferred to the processor, the processor fault status should clear. (The CPU FAULT LED stops if it was flashing.)
8. Enter the Run mode.

   The processor PC RUN LED should turn on indicating the controller is in the RUN mode with no processor faults. If any other processor status exists, refer to chapter 8.
9. Monitor the sample test rung.

   If the sample test rung operates successfully without processor faults, you have verified that basic processor functions are properly functioning. If any other processor status exists, refer to chapter 8.

4. Test Your Inputs

After successful processor initialization and test, you may begin testing inputs following these steps:

1. Assuming you are still online with the programming device, put the controller into the Continuous Test mode. This allows the processor to scan the I/O and program, but not turn on any physical outputs.
2. Monitor the data in data File 1, the input data file. All configured inputs should be displayed.
3. Make sure the first input slot, slot 0, is shown on the monitor.
4. Select the first input device connected to Input 0 of the fixed I/O chassis.
5. Manually close and open the addressed input device.

ATTENTION: Never reach into a machine to actuate a device, unexpected machine operation could occur.

---

685 497

6. Observe the associated bit status using the programming device monitor function. Also, observe the input status LED on the fixed I/O chassis.

   A. When the input device is closed verify that the voltage at the input terminal is within the specified on-state range, the input status LED is on, and the associated status bit is set to a one.

      If any of these conditions are not satisfied, follow the recommended troubleshooting steps listed below.

   B. When the input device is opened verify that the voltage at the input terminal is within the specified off-state range, the input status LED is off, and the associated status bit is reset to 0.

      If any of these conditions are not satisfied, follow the recommended troubleshooting steps listed below.

7. Select the next input device and repeat steps 5 and 6 until all inputs on the fixed I/O chassis and in the 2-slot expansion rack (if used) have been tested.

Input Troubleshooting Steps

1. Make sure the processor is in the Continuous Test mode.
2. Verify that your inputs and outputs are enabled. Status file bit S:11/0 represents the inputs and outputs of the fixed controller. Status file bits S:11/1 and S:11/2 represent the inputs and outputs (slot 1 and slot 2 respectively) of the 2-slot expansion chassis. These bits must be set to one, enabling all your inputs and outputs.
3. Check your wiring and verify that all connections are tight.

   A. Make sure that power connections have been made to your input device if needed.

   B. Verify that the signal connection has been made from the input device to the correct input circuit of the fixed controller.

   C. Check that all common connections have been made.

4. Check your specifications.

   A. Make sure that the power is within the specified voltage range if your input device requires power.

   B. Verify that your power supply is not overloaded. An overloaded supply can deliver the correct voltage when some of its loads are not energized but the voltage may fall out of range when all of its loads are energized.

   C. Verify that your input device signal contact is specified to deliver sufficient current to the input circuit and any other loads connected to it.

   D. Make certain that your input device does not have a minimum load specification that is greater than the input circuit current specificatic

   E. Verify that the input device is on and off longer than the specified turn-on and turn-off times for the input circuit.

685 498

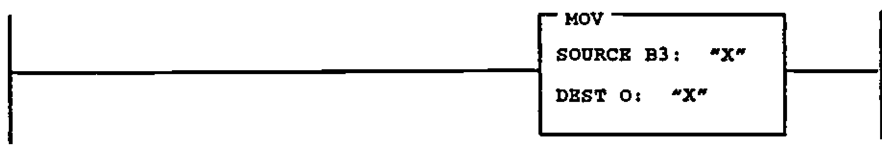
5. Disconnect your input devices from the fixed controller input terminals. Make a direct connection from a power supply to the fixed controller input and common terminals. The power supply voltage must be within the specified on–state voltage range of the input circuit. If you can energize and de–energize the input circuit by turning the power supply on and off, the basic operation of the input circuit is functioning correctly. The problem is likely to be with the input device or wiring. If you cannot operate the the input circuit by a direct connection, the input circuit is not functioning and should be replaced.
6. Connect a different load to your input device. Open and close the input device and measure the voltage at the load. If your input device cannot operate other loads, the input device is not functioning properly and should be replaced.

For more information on input troubleshooting, see page 8–8.

5. Test Your Outputs

After you test all inputs, and have determined that they are functioning properly, test the outputs following these steps.

1. Refer to page 6–2 to insure that no motion will occur when any controller output is energized.
2. Place the controller in the Program mode.
3. Create an output test rung as shown below for each output slot configured. Enter your source and destination address:



   Here "X" represents the slot number of the output currently selected. This rung moves a word of data from the bit file to the output file. The slot number is 0 for outputs of the fixed controller. If the 2–slot expansion chassis is used, numbers one and two are used for the outputs in slots 1 and 2 respectively.

4. Save the output test program and controller configuration.
5. Transfer the output test program to the processor.
6. Put the controller in the Run mode.
7. Monitor the data in bit file B3 on the programming device display.
8. Enter B3: "X" at the address prompt to select the output slot to be tested.
9. Move the cursor to the bit position that corresponds to the specific output being tested. Set the bit to 1.

10. Observe the output status LED and the output device.

    The output status LED should turn on. The output device should be energized unless you disconnected it to prevent machine motion. It may be necessary to connect a dummy load to the output to complete this test. If the LED does not turn on or if the load is not energized, follow the output troubleshooting steps listed below.

11. Reset the bit value back to zero for the selected address. Both the output status LED and the output device should de–energize. If the LED does not turn off or if the load does not de–energize, follow the output troubleshooting steps listed below.

12. Repeat steps 9 through 11 for all outputs of the selected slot.

13. Repeat steps 8 through 12 for all slots (with outputs) that are a part of the fixed controller configuration.

Output Troubleshooting Steps

1. Make sure the processor is in the Run mode.

2. Verify that the test rung recommended in the previous section has been entered correctly.

3. Check the status file I/O slot enable bits. Status file bit S:11/0 represents the inputs and outputs of the fixed controller. Status file bits S:11/1 and S:11/2 represent the inputs and outputs (slot 1 and slot 2 respectively) on the 2–slot expansion chassis. These bits must be set to one, enabling all your inputs and outputs.

4. Use a programming device to verify that the bit being tested in the output file tracks the on/off status of the corresponding bit in the bit file.

   If the output file does not track the bit file, but your program has been entered correctly and the I/O are enabled, then your processor is not functioning properly and should be replaced.

   If the output file tracks the bit file, then the processor is functioning properly and the output command is being sent to either the I/O section of the fixed controller, or to the output module in the 2–slot expansion chassis.

5. Check the electrical connections.

   A. If the output being tested is in the 2–slot expansion chassis, verify that the expansion chassis connector is properly mated to the expansion connector of the fixed controller.

   B. Turn off power to the I/O circuits. Verify that power and/or common connections are made to the proper output circuit terminals.

   C. Verify that the power connections are made to the output load device if they are required.

   D. Verify that the output terminal being tested is connected to the correct termination point of the load device.

   E. Check the tightness of all terminals to make certain that all wires are secure.

6. Check your specifications.

   A. Verify that all power supplies used are within the specified operating ranges of the I/O circuits and loads.

   B. Check that the specified load current is greater than the minimum load current specified for the output circuit. (Leakage current from the output circuit may prevent you from turning off a low current load.)

   C. Check that the specified load current is less than the maximum load current of the output circuit.

   D. Make sure that the sum of all the load currents is equal to or less than the power supply capacity.

7. Restore power to the I/O circuits and test the output. If the preceding measures have not corrected the problem, turn off the I/O power and disconnect the load. Connect the load directly to the I/O power supply. You should be able to operate the load by turning the power supply on and off.

   If you can operate the load, and the load is within the specified operating range of the output circuit, the output circuit is not functioning properly. Replace the fixed controller or output module as necessary.

   If you cannot operate the load by turning the power supply on and off, the load is not operating properly and it should be replaced.

For more information on output troubleshooting, refer to page 8–10.

6. Enter and Test Your Program

After you test all inputs and outputs and they are functioning properly, we recommend the following steps to safely and successfully enter and test your specific application program. (For extra assistance, see the *Hand–Held Terminal User Manual* or the *Advanced Programming Software User Manual.*)

1. Verify the offline program.

   After the program has been entered in the offline edit file mode, program verification may begin.

   Remaining in the offline edit file mode you may use the cursor keys and/or search function of your programming device to inspect every instruction and rung for errors.

2. Check your written program, rung for rung, against the program entered into the offline memory. The most common errors found in program entry are:

   - incorrect addressing of instructions
   - omission of an instruction
   - more than one output instruction programmed using the same address

685 501

3. Transfer the program into the processor.

   A. Place your programming device online.

   B. Place the processor in Program mode.

   C. Select download function when using the Hand–Held Terminal or the restore function when using Advanced Programming Software.

4. Verify the online program transfer.

   A. Select monitor file function.

   B. Cursor through the program to verify that you selected the right program.

5. Conduct a single–scan program test.

   A. Select the monitor file function and place the cursor on the first rung.

   B. Select the Test mode.

   C. Select Single–Scan (SSN) test. In this test mode, the processor executes a single operating cycle, which includes reading the inputs, executing the ladder program, and updating all data without energizing the output circuits. However, the monitor file function will identify the output status as if the outputs were enabled.

      Timers are also incremented a minimum of 10 milliseconds each single scan.

   D. Simulate the input conditions necessary to execute the current monitored rung of the program. If it is not practical to manually activate the input device, use the force function to simulate the proper condition.

ATTENTION: Never reach into a machine to actuate a device, unexpected machine operation could occur.

   E. Activate a single operating scan as outlined in the programming device user manual.

   F. Verify the intended effects on the output instructions for that rung and overall program logic effects.

   G. Select the next program rung and repeat test procedures as listed above until the entire program has been tested.

6. Conduct a continuous scan program test.

   Once the individual single scan rung tests have been completed and proper program operation verified, a continuous scan test might be appropriate before motion checkout.

   This mode simulates the controller Run mode without energizing the external outputs.

7. Observe Control Motion

Now that program execution has been verified, checkout of control motion can begin. All persons involved with the programming, installation, layout design, machine or process design, and maintenance should be involved in making decisions for determining the best and safest way to test the total system.

The following procedures are general in nature. Individual conditions may warrant their modification. The basic approach is to initiate testing with the least amount of machine motion. Only some outputs are allowed to generate machine motion. Then additional machine motion can be gradually added, thereby allowing any problems to be detected more easily under controlled conditions. The following procedure provides the steps for testing machine motion using one output at a time.

ATTENTION: During all phases of checkout, station a person ready to operate an emergency–stop switch if necessary. The emergency–stop switch will de–energize the master control relay and remove power from the machine. This circuit must be hardwired only, it *must not* be programmed.

Use the following procedures:

1. Identify the first output device to be tested and reconnect its wiring.

ATTENTION: Contact with AC line potential may cause injury to personnel. When reconnecting wiring, make sure that AC power disconnect switch is opened.

---

2. Place the controller in the Run mode and observe the behavior of the output device. To do this, simulate the input conditions necessary to energize the output in the program. If it is not practical to manually activate an input device, use the force function to simulate the proper input condition.

ATTENTION: Never reach into a machine to actuate a device, unexpected machine operation could occur.

---

3. Repeat steps 1 and 2, testing each output device, one at a time.

685 503

8. Conduct a Dry Run

ATTENTION: During all phases of the dry run test, station a person ready to operate an emergency–stop switch if necessary. The emergency–stop switch will de–energize the master control relay and remove power from the machine. This circuit must be hardwired only, it *must not* be programmed.

After thoroughly checking out the controller system and program, proceed with a dry run of the application with all of the output devices enabled. This dry run will vary with the application. For example, a machine tool dry run might test the program with all outputs enabled but without tooling an actual part.

After you check out the entire system, and your dry run has been completed satisfactorily, we recommend that you load your program into an EEPROM memory module for back–up program storage. See chapter 3 for more information. Refer to the *Hand–Held Terminal User Manual,* Catalog Number 1747–NP002, or the *Advanced Programming Software User Manual,* Catalog Number 1747–NM002, for directions on loading the EEPROM from RAM.

This step completes the start–up procedures. Your SLC Programmable Controller is now ready for operation.

Maintaining Your Control System

This chapter covers the following:

- handling, storing, and transporting battery, Catalog Number 1747–BA
- installing or replacing your SLC 500 battery
- replacing the power supply fuse
- replacing retainer clips on a module

Refer to chapter 2 for important information on testing the master control relay circuit and preventive maintenance.

Handling, Storing, and Transporting Battery, Catalog Number 1747–BA

Follow the procedure below to ensure proper battery operation and reduce personnel hazards.

Handling

- Use only for the intended operation.
- Do not ship or dispose of batteries except according to recommended procedures.
- Do not ship on passenger aircraft.

ATTENTION: Do not charge the batteries. An explosion could result or they could overheat causing burns.

Do not open, puncture, crush, or otherwise mutilate the batteries. A possibility of an explosion exists and/or toxic, corrosive, and flammable liquids would be exposed.

Do not incinerate or expose the batteries to high temperatures. Do not attempt to solder batteries. An explosion could result.

Do not short positive and negative terminals together. Excessive heat could build up and cause severe burns.

Storing

Store the lithium batteries in a cool, dry environment, typically +20° C to +25° C (+68° F to +77° F) and 40% to 60% relative humidity. Store the batteries and a copy of the battery instruction sheet in the original container, away from flammable materials.

Transporting

One or Two Batteries – Each battery contains 0.23 grams of lithium. Therefore, up to two batteries can be shipped together within the United States without restriction. Regulations governing shipment to or within other countries may differ.

Three or More Batteries – Procedures for the transportation of three or more batteries shipped together within the United States are specified by the Department of Transportation (DOT) in the Code of Federal Regulations, CFR49, "Transportation." An exemption to these regulations, DOT – E7052, covers the transport of certain hazardous materials classified as flammable solids. This exemption authorizes transport of lithium batteries by motor vehicle, rail freight, cargo vessel, and cargo–only aircraft, providing certain conditions are met. Transport by passenger aircraft is not permitted.

A special provision of DOT–E7052 (11th Rev., October 21, 1982, par. 8–a) provides that:

> "Persons that receive cell and batteries covered by this exemption may reship them pursuant to the provisions of 49 CFR 173.22a in any of these packages authorized in this exemption including those in which they were received."

The Code of Federal Regulations, 49 CRF 173.22a, relates to the use of packaging authorized under exemptions. In part, it requires that you must maintain a copy of the exemption at each facility where the packaging is being used in connection with shipment under the exemption.

Shipment of depleted batteries for disposal may be subject to specific regulation of the countries involved or to regulations endorsed by those countries, such as the IATA Restricted Articles Regulations of the International Air Transport Association, Geneva, Switzerland.

Important: Regulations for transportation of lithium batteries are periodically revised.

ATTENTION: Do not incinerate lithium batteries in general trash collection. Explosion or violent rupture is possible. Batteries should be collected for disposal in a manner to prevent against short circuiting, compacting, or destruction of case integrity and hermetic seal.

For disposal, batteries must be packaged and shipped in accordance with transportation regulations, to a proper disposal site. The U.S. Department of Transportation authorizes shipment of "Lithium batteries for disposal" by motor vehicle only in regulation 173.1015 of CRF49 (effective January 5, 1983). For additional information contaet:

U.S. Department of Transportation
Research and Special Programs Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

Although the Environmental Protection Agency at this time has no regulations specific to lithium batteries, the material contained may be considered toxic, reactive, or corrosive. The person disposing of the material is responsible for any hazard created in doing so. State and local regulations may exist regarding the disposal of these materials.

685 507

Installing or Replacing Your SLC 500 Battery

Back–up power for RAM is provided by a capacitor that will retain the contents of the RAM for a period of 5 to 30 days. For applications requiring memory back–up for a longer period of time an optional replaceable battery, Catalog Number 1747–BA, is required. The lithium battery provides back–up for approximately five years. A red BATTERY LOW LED turns on when the battery voltage has fallen below a threshold level.

For battery installation or replacement, do the following:

1. Back up your ladder program.
2. Disconnect power to the processor.

ATTENTION: When power is applied to the controller hazardous electrical potentials exist under the front cover. See page 2–8 for more information.

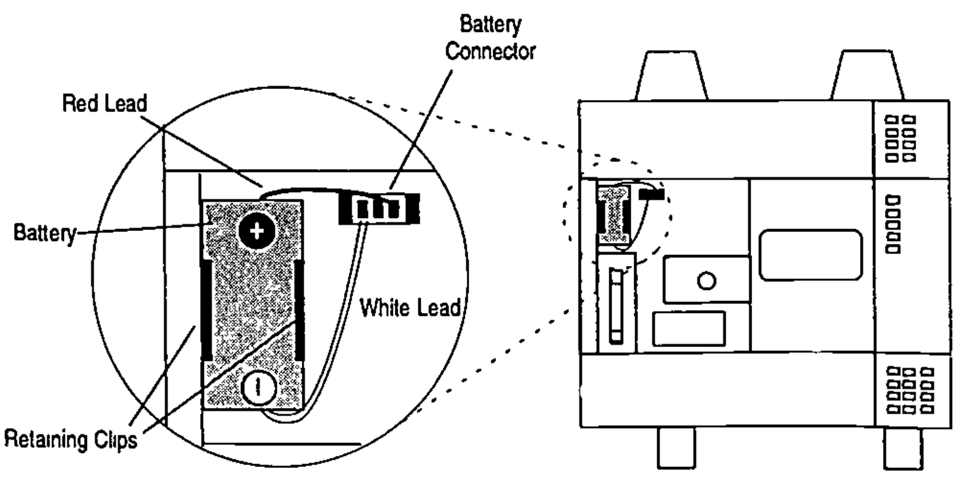
---

3. Remove the processor cover
4. If you are:

   installing a battery in a new processor (battery never installed before), remove the jumper from the battery socket. Store jumper in safe place for possible future use without battery.

   replacing an old battery, unplug the battery connector from the socket. The figure below shows you where to install the battery in a fixed controller.

5. Insert a new or replacement battery in the holder making sure it is held in by the retaining clip.
6. Plug the battery connector into the socket. See the figure below.



7. Replace the cover.

Replacing the Power Supply Fuse

Under normal power–up conditions, the POWER LED turns on. If a power supply fuse is blown, the POWER LED will not turn on. One of the following conditions could cause a blown power supply fuse:

- excessive line voltage
- internal power supply malfunction
- overloading 2–slot chassis

ATTENTION: Contact with AC line potential can cause injury to personnel. Remove system power before attempting fuse replacement.

Use only replacement fuses of the type and rating recommended for the unit. Improper fuse selection can result in equipment damage.

After the conditions causing the malfunction have been corrected, you can replace the fuse:

1. Disconnect power to the processor.

ATTENTION: When power is applied to the controller hazardous electrical potentials exist under the front cover. See page 2–8 for more information.

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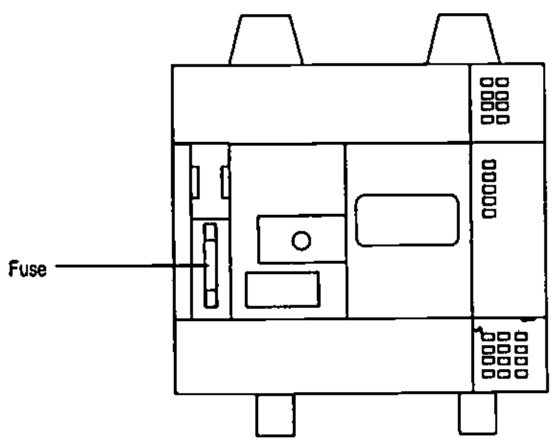
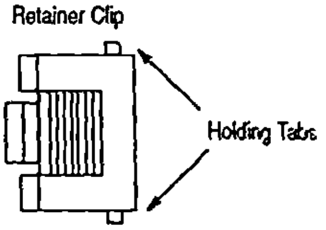
2. Remove the cover on the processor.
3. Locate the fuse. Use a miniature fuse puller to grip the fuse and remove it from its holder.
4. Discard the fuse and replace it with the recommended replacement fuse. (See chapter 9 for more information.)



5. Replace the cover on the processor.
6. Restore power to the processor. The POWER LED should now turn on.

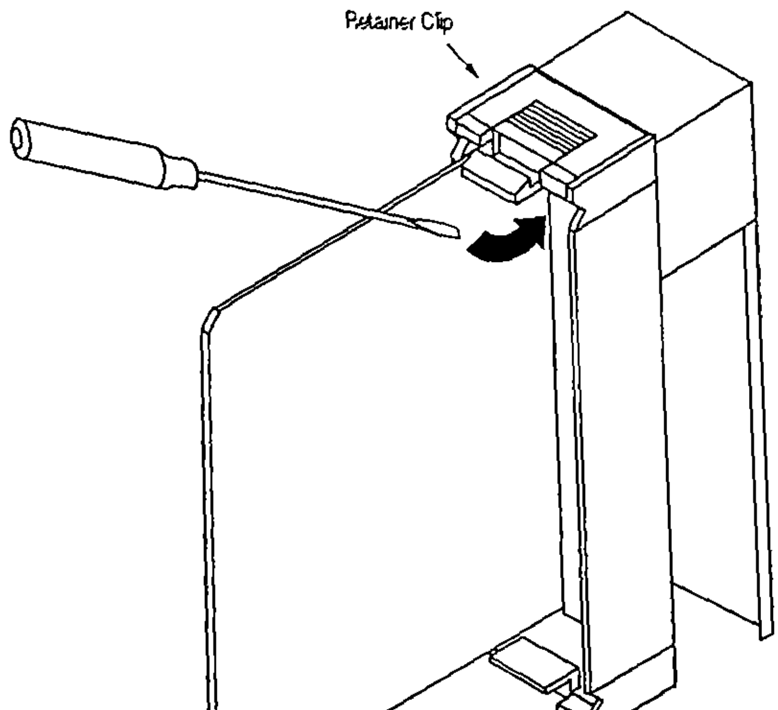
Replacing Retainer Clips on an I/O Module

If it becomes necessary to replace the retainer clip (also called self-locking tab), order Catalog Number 1746-R15 (4 clips per package).



Removing Damaged Retainer Clips

If necessary, pry off the broken retainer clip from the bottom with a screwdriver. Do not twist it off. You can damage the module.



Installing New Retainer Clips

Insert one of the pins of the retainer clip into the hole in the I/O module and then snap the other end in place.

Chapter 8

Troubleshooting

In this chapter, you will learn about:

- calling Allen–Bradley for assistance
- tips for troubleshooting your control system
- troubleshooting your fixed controller
- troubleshooting your input modules
- troubleshooting your output modules

Calling Allen–Bradley for Assistance

If you need to contact Allen–Bradley or your local distributor for assistance, it is helpful to obtain the following (prior to calling):

- processor type, series letter, and firmware (FRN) number (see label on side of processor module)
- processor LED status
- processor error codes (found in S:6 of status file)
- hardware types in system (I/O modules, chassis)
- revision of programming device (on the main menu of the Hand–Held Terminal or Advanced Programming Software)

Tips for Troubleshooting Your Control System

When troubleshooting, pay careful attention to these general warnings:

ATTENTION: Have all personnel remain clear of the controller and equipment when power is applied. The problem may be intermittent and sudden unexpected machine motion could result in injury. Have someone ready to operate an emergency–stop switch in case it becomes necessary to shut off power to the controller equipment. Also, see NFPA 70E Part II for additional guidelines for safety related work practices.

Never reach into a machine to actuate a switch since unexpected machine motion can occur and cause injury.

Remove all electrical power at the main power disconnect switches before checking electrical connections or inputs/outputs causing machine motion.

If installation and start–up procedures detailed in chapters 3, 4, and 5 were followed closely, your SLC controller will give you reliable service. If a problem should occur, the first step in the troubleshooting procedure is to identify the problem and its source.

The SLC 500 controller has been designed to simplify troubleshooting procedures. By observing the diagnostic indicators on the front of the processor unit and I/O modules, the majority of faults can be located and corrected. These indicators, along with error codes identified in the programming device user manual and programmer's monitor, help trace the source of the fault to the user's input/output devices, wiring, or the controller.

Removing Power

Before working on a SLC 500 fixed system, always remove the power supply input power at the main power disconnect switch.

The POWER LED on the power supply indicates that DC power is being supplied to the chassis. This LED could be off when incoming power is present when the:

- fuse is blown
- voltage drops below the normal operating range. Refer to chapter 1 for more information.
- power supply is defective

Replacing Fuses

When replacing a fuse, be sure to remove all power from the system.

Program Alteration

There are several causes of alteration to the user program, including extreme environmental conditions, Electromagnetic Interference (EMI), improper grounding, improper wiring connections, and unauthorized tampering. If you suspect the memory has been altered, check the program against a previously saved program on an EEPROM, UVPROM or Flash EPROM module.

Troubleshooting Your Fixed Controller

To receive the maximum benefit of this troubleshooting section, we recommend you follow these steps:

1. Match your processor LEDs with the status LEDs located in the first column in the tables on the following pages.
2. Once the status LEDs are matched to the appropriate table, simply move across the table identifying error description and probable causes.
3. Follow the recommended action steps for each probable cause until the cause is identified.
4. If recommended actions do not identify the cause, contact your local Allen–Bradley sales office or distributor.

685 513

Identifying Fixed Controller Errors

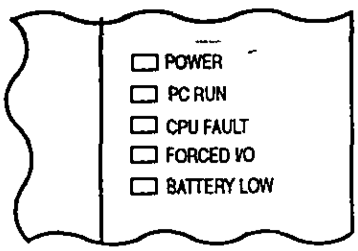
Refer to the following key to determine the status of the LED indicators:

☐ Indicates the LED is OFF.

■ Indicates the LED is ON.

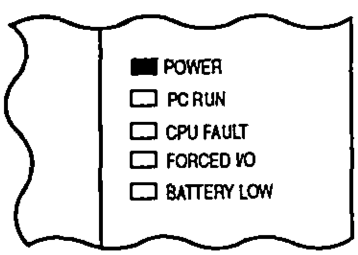
☐ Indicates the LED is FLASHING.

If the LEDs indicate:



The Following Error Exists	Probable Cause	Recommended Action
Inadequate System Power	No Line Power	Verify proper line voltage and connections on the power terminals.
	Power Supply Fuse Blown	1. Check the incoming power fuse, check for proper incoming power connections. Replace fuse. 2. If fuse blows again, replace the fixed controller.
	Power Supply Overloaded	This problem can occur intermittently if power supply is lightly overloaded when output loading and temperature varies. If you are using a 2–slot chassis, verify the compatibility of the modules to prevent overloading the backplane power.

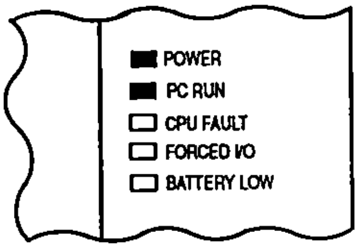
If the LEDs indicate:



The Following Error Exists	Probable Cause	Recommended Action
Processor Not in Run Mode	Either Improper Mode Selected or User Program Logic Error	1. Verify selected processor mode. 2. If in program/test modes, attempt RUN mode entry 3. Check user program logic for suspend instructions if in suspend mode. Refer to either the *Hand–Held Terminal User Manual,* Catalog Number 1747–NP002, or the *Advanced Programming Software User Manual,* Catalog Number 1747–NM002.
	Line Power Out of Operating Range	1. Check incoming power connections. 2. Monitor for proper line voltage at the incoming power connections.

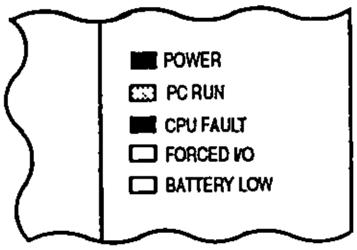
685 514

If the LEDs indicate:



The Following Error Exists	Probable Cause	Recommended Action
System Inoperable, No Major CPU Faults Detected	User Program Logic Error	Monitor logic in Run mode and verify desired I/O status. Refer to either the *Hand-Held Terminal User Manual*, Catalog Number 1747-NP002, or the *Advanced Programming Software User Manual*, Catalog Number 1747-NM002.
	Defective I/O Devices or I/O Wiring	Test inputs and outputs according to I/O troubleshooting procedures starting on page 8-8.

If the LEDs indicate:



The Following Error Exists	Probable Cause	Recommended Action
CPU Fault	CPU Memory Error	Cycle power.
	Faulty Memory Module	1. Remove power and then remove the memory module from the controller. 2. Re-energize the controller. If steady CPU FAULT LED changes to flashing, replace the existing memory module with a replacement module. Refer to chapter 4 for removing and installing memory modules.
	Processor Firmware Installed Incorrectly	If upgrading the processor to a different firmware level, verify that the firmware chip orientation matches the upgrade kit directions.

Refer to the following key to determine the status of the LED indicators:

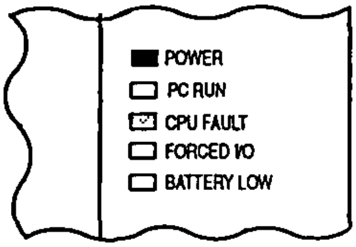
☐ Indicates the LED is OFF.

■ Indicates the LED is ON

▨ Indicates the LED is FLASHING.

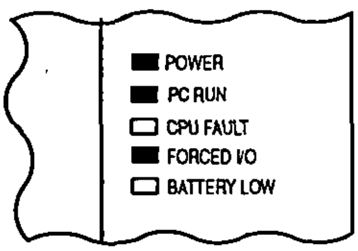
685 515

If the LEDs indicate:



The Following Error Exists	Probable Cause	Recommended Action
CPU Major Fault	Initial CPU Factory Power-up Condition	1. Refer to chapter 6 and follow the start-up procedures. 2. Clear processor memory to get rid of the flashing CPU FAULT LED.
	Hardware/Software Major Fault Detected Erratic repetitive power cycling can cause a processor major hardware fault.	1. Monitor Status File Word S:6 for major error code. 2. Refer to either the *Hand-Held Terminal User Manual,* Catalog Number 1747-NP002, or the *Advanced Programming Software User Manual,* Catalog Number 1747-NM002, for error codes and additional troubleshooting information. 3. Remove hardware/software condition causing fault. 4. Clear Status File S:1/13 major error bit, if set. 5. Clear Status File S:5 minor error bits, if set. 6. Clear Status File S:6 major error code (optional). 7. Attempt a processor Run mode entry. If unsuccessful, repeat recommended action steps above

If the LEDs indicate:



The Following Error Exists	Probable Cause	Recommended Action
System does not operate per ladder logic.	User Forced I/O Disabling Operation	1. Monitor program file online and identify forced I/O. 2. Disable appropriate forces and test system conditions again. Refer to either the *Hand-Held Terminal User Manual,* Catalog Number 1747-NP002, or the *Advanced Programming Software User Manual,* Catalog Number 1747-NM002.

Refer to the following key to determine the status of the LED indicators:

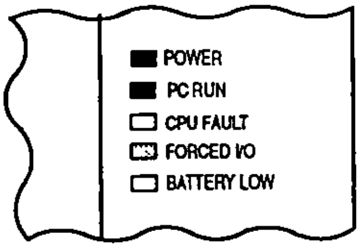
☐ Indicates the LED is OFF.

■ Indicates the LED is ON.

▨ Indicates the LED is FLASHING.

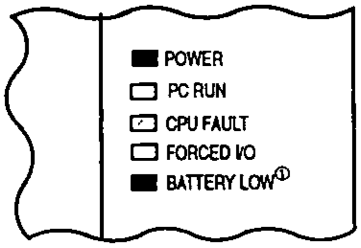
685 516

If the LEDs indicate:



The Following Error Exists	Probable Cause	Recommended Action
System does not operate per programmed forces.	User Programmed Forces are Not Enabled	1. Monitor program file online and identify programmed forces. 2. Enable appropriate forces and test system conditions again. Once forces are enabled, the FORCED I/O LED goes on steady. Refer to either the *Hand-Held Terminal User Manual*, Catalog Number 1747-NP002, or the *Advanced Programming Software User Manual*, Catalog Number 1747-NM002.

If the LEDs indicate:



The Following Error Exists	Probable Cause	Recommended Action
CPU Major Error with Low or No Battery Back-up	Loss of RAM during Power Down Period	1. Verify battery is connected. See page 7-4. 2. Replace the battery. See page 7-4. 3. Refer to processor major fault recommended action steps Refer to either the *Hand-Held Terminal User Manual*, Catalog Number 1747-NP002, or the *Advanced Programming Software User Manual*, Catalog Number 1747-NM002.

Refer to the following key to determine the status of the LED indicators:

☐ Indicates the LED is OFF.

■ Indicates the LED is ON.

▨ Indicates the LED is FLASHING.

① *Regardless of any other LED status indicator conditions, always replace the battery when the BATTERY LOW LED is on if you want RAM battery backup. If you want to back up RAM with a capacitor, add or replace the BATTERY LOW LED jumper.*

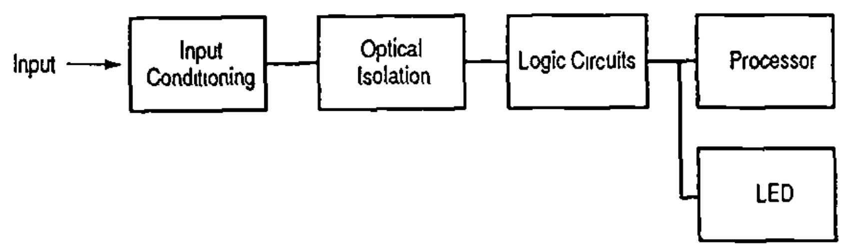
Troubleshooting Your Input Modules

The following will assist you in troubleshooting your input modules.

Input Circuit Operation

An input circuit responds to an input signal in the following manner:

1. An input filter removes false signals due to contact bounce or electrical interference.
2. Optical isolation protects the backplane circuits by isolating logic circuits from input signals.
3. Logic circuits process the signal.
4. An input LED turns on or off indicating the status of the corresponding input device.



5. The processor receives the input status for use in processing the program logic.

Corrective Action

If your Input Circuit LED is	And Your Input Device is	And	Probable Cause	Recommended Action
On	On/Closed/Activated	Your input device will not turn off.	Device is shorted or damaged.	Verify device operation. Replace device.
		Your program operates as though it is off.	Input is forced off in program.	Check the FORCED I/O or FORCE LED on processor and remove forces.
			Input circuit is damaged.	Try other input circuit. Replace module
	Off/Open/Deactivated	Your program operates as though it is on and/or the input circuit will not turn off.	Input device Off–state leakage current exceeds input circuit specification.	Check device and input circuit specifications. Use load resistor to bleed–off current.
			Input device is shorted or damaged	Verify device operation. Replace device.
			Input circuit is miswired or damaged.	Verify proper wiring. Try other input circuit. Replace module.
Off	On/Closed/Activated	Your program operates as though it is off and/or the input circuit will not turn on.	Input circuit is incompatible	Check specification and sink/source compatibility (if DC input).
			Low voltage across the input.	Check the voltage across input circuit and check source voltage.
			Incorrect wiring or an open circuit.	Check wiring and COMmon connections.
			Input signal turn on time too fast for input circuit.	Check timing specifications.
			Input circuit is damaged.	Verify proper wiring. Try other input circuit. Replace module.
	Off/Open/Deactivated	Your input device will not turn on.	Input device is opened or damaged.	Verify operation. Replace device.
		Your program operates as though it is on.	Input is forced on in program.	Check processor FORCED I/O or FORCE LED and remove forces. Verify proper wiring. Try other input circuit.
			Input circuit is damaged.	Verify proper wiring. Try other input circuit. Replace module.

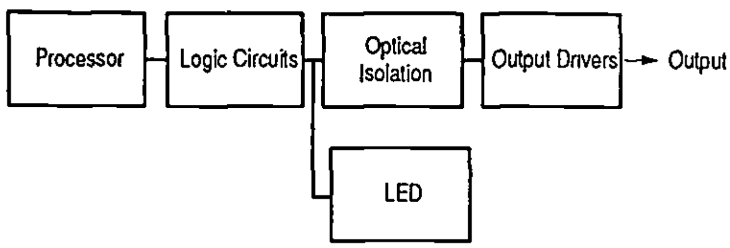
Troubleshooting Your Output Modules

The following will assist you in troubleshooting your output modules.

Output Circuit Operation

An output circuit controls the output signal in the following manner:

1. The processor determines the output status.
2. Logic circuits maintain the output status.
3. An output LED indicates the status of the output signal.
4. Optical isolation separates logic and backplane circuits from field signals.
5. The output driver turns the corresponding output on or off.



Corrective Action

If your Output Circuit LED is	And Your Output Device is	And	Probable Cause	Recommended Action
On	On/Energized	Your program indicates that the output circuit is off or the output circuit will not turn off.	Programming problem.	Check for duplicate outputs and addresses using the search function. If using subroutines, outputs are left in their last state when not executing subroutines. Use the force function to force output off. If this does not force the output off, output circuit is damaged. If the output does force off, then check again for logic/programming problem.
			Output is forced on in program.	Check processor FORCED I/O or FORCE LED and remove forces.
			Output circuit is damaged.	Use the force function to force the output off. If this forces the output off, then there is a logic/programming problem. If this does not force the output off, the output circuit is damaged. Try other output circuit. Replace module.
	Off/De-energized	Your output device will not turn on and the program indicates that it is on.	Low or no voltage across the load	Measure the source voltage and check specifications
			Incorrect wiring or open circuit.	Check wiring and COMmon connections.
			Output device is incompatible.	Check specifications and sink/source compatibility (if DC output).
			Output circuit is damaged.	Check wiring. Try other output circuit. Replace module.
Off	On/Energized	Your output device will not turn off and the program indicates that it is off.	Output device is incompatible.	Check specifications.
			Output circuit Off-state leakage current may exceed output device specification	Check specifications. Use load resistor to bleed off leakage current. See output specifications.
			Incorrect wiring.	Check wiring. Disconnect from SLC and verify device operation.
			Output device is shorted or damaged.	Verify device operation. Replace device.
			Output circuit is damaged.	Check wiring. Try other output circuit. Replace module.
	Off/De-energized	Your program indicates that the output circuit is on or the output circuit will not turn on.	Programming problem.	Check for duplicate outputs and addresses using search function. If using subroutines, outputs are left in their last state when not executing subroutines. Use the force function to force output on. If this does not force the output on, output circuit is damaged. If the output does force on, then check again for logic/programming problem.
			Output is forced off in program.	Check processor FORCED I/O or FORCE LED and remove forces.
			Output circuit is damaged.	Use the force function to force the output on. If this forces the output on, then there is a logic/programming problem. If this does not force the output on, the output circuit is damaged. Try other output circuit. Replace module

685 521

Chapter 9

Replacement Parts

This chapter provides a list of replacement parts and a list of replacement terminal blocks for your SLC 500 controller.

Replacement Parts

This table provides a list of replacement parts and their catalog numbers.

Description	Catalog Number
Pre–wired Interface Cable — Available in 1.0m, 2.5m, and 5.0m lengths.	1492–CABLE[1]H
Replacement Fuses — Five fuses per package. Orders must be for five fuses or multiples of five.	
Replacement fuse for Fixed I/O AC units, MDL 1.25 Ampere	1746–F4
Replacement fuse for Fixed I/O DC units, MDL 1.6 Ampere	1746–F5
Modular Card Slot Fillers — Two fillers per package. Orders must be for two fillers or multiples of two	1746–N2
Connector — Mating Connector for 32 Point user–made cable	1746–N3
Kit consisting of four replacement terminal covers and labels for 4, 8, 16 I/O modules	1746–R9
Replacement Cover for Specialty I/O Two covers per package. Orders must be for two covers or multiples of two	1746–R13
Replacement Retainer Clips for Modules Four clips per package. Orders must be for four clips or multiples of four.	1746–R15
Lithium Battery Assembly This is an optional part used for the SLC 500 Fixed and Modular Hardware Style processors and the Hand–Held Terminal Refer to product documentation for proper storage and handling instructions For disposal information, consult your nearest Allen–Bradley Sales Office	1747–BA
Processor to Peripheral Programming/Communication Cable	1747–C10
Processor to Isolated Link Coupler Cable	1747–C11
Specialty Module to Isolated Link Coupler Cable	1747–C13
EEPROM with 1K User Instructions	1747–M1
UVPROM with 1K User Instructions	1747–M3
Adapter Sockets — Orders must be for five sockets or multiples of five.	1747–M5
Replacement Parts Kit for 20 I/O Fixed Hardware Style Processor Two Output Terminal Covers Two Input Terminal Covers Two Prom/Battery Covers One HHT/Comm Connector Cover	1747–R5
Replacement Parts Kit for 30 and 40 I/O Fixed Hardware Style Processors Two Output Terminal Covers Two Input Terminal Covers Two Prom/Battery Covers One HHT/Comm Connector Cover	1747–R7
Replacement Terminal Covers for 4, 8, & 16 I/O Modules This kit contains four blank covers and appropriate labels for replacement of any required I/O module cover.	1747–R9
HHT Keypad Replacement Overlay for English Memory Pak Firmware Releases 1.02, 1.07 and 1.10	1747–R20
HHT Keypad Replacement Overlay for French Memory Pak Firmware Releases 1.10	1747–R20F
HHT Keypad Replacement Overlay for German Memory Pak Firmware Releases 1.10	1747–R20G
HHT Keypad Replacement Overlay for Italian Memory Pak Firmware Releases 1.10	1747–R20I
HHT Keypad Replacement Overlay for English Memory Pak Firmware Releases 2.00 and Later	1747–R21
HHT Keypad Replacement Overlay for French Memory Pak Firmware Releases 2.00 and Later	1747–R21F

[1] *Insert the cable length code into the catalog number Cable length codes are as follows 10=1 0m, 25=2 5m, and 50=5 0m For example, 1492–CABLE25H is a 2 5m cable*

685 522

Replacement Terminal Blocks

This table provides a list of replacement terminal blocks and their catalog numbers.

Description	Catalog Number
Replacement Terminal Block (Red) — Used with AC I/O modules, Catalog Numbers 1746–IA16, OA16, IM16	1746–RT25R
Replacement Terminal Block (Blue) — Used with DC I/O modules, Catalog Numbers 1746–IB16, IV16, OB16, OV16, IN16, IG16, OG16	1746–RT25B
Replacement Terminal Block (Orange) — Used with relay output modules, Catalog Numbers 1746–OW16, OX8	1746–RT25C
Replacement Terminal Block (Green) — Used with Specialty I/O modules, Catalog Numbers 1746–HSCE, IO12	1746–RT25G
Replacement Terminal Block — 2 position terminal block used with analog output modules, Catalog Numbers 1746–NO4I, NO4V	1746–RT26
Replacement Terminal Block — 8 position terminal block used with analog output modules, Catalog Numbers 1746–NO4I, NO4V	1746–RT27
Replacement Terminal Block — Used with analog input modules, Catalog Numbers 1746–NI4, NIO4I, NIO4V	1746–RT28
Replacement Terminal Block — Used with RIO Communication Modules, Catalog Numbers 1747–SN, DSN, DCM	1746–RT29
Replacement Terminal Block — Used with DH–485 Link Coupler, Catalog Number 1747–AIC	1746–RT30

685 523

Appendix A

Setting Up the DH–485 Network

The information in this appendix will help you plan, install, and operate the SLC 500 in a DH–485 network. This chapter also contains information that describes the DH–485 network functions, network architecture, and performance characteristics. It also covers:

- DH–485 network description
- DH–485 network protocol
- DH–485 token rotation
- DH–485 network initialization
- devices that use the DH–485 network
- 1747–AIC isolated link coupler for DH–485
- example system configuration
- important planning considerations
- DH–485 network installation

DH–485 Network Description

We have designed the DH–485 network to pass information between devices on the plant floor. The network monitors process parameters, device parameters, device status, process status and application programs to support data acquisition, data monitoring, program upload/download and supervisory control.

The DH–485 network offers:

- interconnection of 32 devices
- multi–master capability
- token passing access control
- the ability to add or remove nodes without disrupting the network
- maximum network length of 1219 m (4000 ft)

DH–485 Network Protocol

The following section describes the protocol used to control message transfers on the DH–485 network. The protocol supports two classes of devices: initiators and responders. All initiators on the network get a chance to initiate message transfers. To determine which initiator has the right to transmit, a token passing algorithm is used.

DH-485 Token Rotation

A node holding the token can send any valid packet onto the network. Each node is allowed only one transmission (plus two retries) each time it receives the token. After a node sends one message packet, it attempts to give the token to its successor by sending a "token pass" packet to its successor.

If no network activity occurs, the initiator sends the token pass packet again. After two retries (a total of three tries) the initiator will attempt to find a new successor.

Important: The maximum address that the initiator will search for before wrapping to zero is the value in the configurable parameter "maximum node address." The default value for this parameter is 31 for all initiators and responders.

The allowable range of the node address of an initiator is 0 to 31. The allowable address range for all responders is 1 to 31. There must be at least one initiator on the network.

DH-485 Network Initialization

Network initialization begins when a period of inactivity exceeding the time of a link dead timeout is detected by an initiator on the network. When the time for a link dead timeout is exceeded, usually the initiator with the lowest address claims the token. When an initiator has the token it will begin to build the network. The network requires at least one initiator to initialize it.

Building a network begins when the initiator that claimed the token tries to pass the token to the successor node. If the attempt to pass the token fails, or if the initiator has no established successor (for example, when it powers up), it begins a linear search for a successor starting with the node above it in the addressing.

When the initiator finds another active initiator, it passes the token to that node, which repeats the process until the token is passed all the way around the network to the first node. At this point, the network is in a state of normal operation.

685 525

Devices that Use the DH–485 Network

Presently, the following SLC 500 devices support the DH–485 network:

- SLC 500 Fixed I/O Controller (responder)
- SLC 5/01 Modular I/O Controller (responder)
- SLC 5/02 Modular I/O Controller (initiator/responder)
- SLC 5/03 Modular I/O Controller (initiator/responder)
- Personal computer running SLC 500 Advanced Programming Software (initiator)
- Hand–Held Terminal (initiator)
- DTAM (initiator/responder)

Other devices that use the DH–485 network include those in the table below.

Catalog Number	Description	Installation Requirement	Function	Publication
1746–BAS	BASIC Module	SLC Chassis	Provides an interface for SLC 500 devices to foreign devices. Program in BASIC to interface the 3 channels (2 RS–232 and 1 DH485) to pnnters, modems, or the DH–485 network for data collection.	1746–ND005 1746–NM002 1746–NM001
1747–KE	DH–485/DF1 Interface Module	SLC Chassis	Provides a non–isolated DH–485 interface for SLC 500 devices to host computers over RS–232 using full– or half–duplex DF1 protocol Enables remote programming with APS to an SLC 500 processor or the DH–485 network through modems. Ideal for low cost RTU/SCADA applications.	1747–NU001
1770–KF3	DH–485/DF1 Interface Module	Standalone ("desktop")	Provides an isolated DH–485 interface for SLC 500 devices to host computers over RS–232 using full– or half–duplex DF1 protocol. Enables remote programming with APS to an SLC 500 processor or the DH–485 network through modems.	1770–6.5 18
1784–KR	PC DH–485 Interface Module	IBM XT/AT Computer Bus	Provides an isolated DH–485 port on the back of the computer. When used with APS software, it improves communication speed and eliminates use of the Personal Interface Converter (1747–PIC). The Standard Driver allows you to write "C" programs for data acquisition applications.	1784–2.23 6001–6.5.5
1785–KA5	DH+™/DH485 Gateway	(1771) PLC® Chassis	Provides communication between stations on the PLC–5 (DH+) and SLC 500 (DH–485) networks. Enables communication and data transfer from PLC to SLC 500 on DH–485 network. Also enables APS programming or data acquisition across DH+ to DH–485	1785–6.5.5 1785–1.21
2760–RB	Flexible Interface Module	(1771) PLC Chassis	Provides an interface for SLC 500 (using protocol cartridge 2760–SFC3) to other A–B PLCs and devices Three configurable channels are available to interface with Bar Code, Vision, RF, Dataliners, and PLC systems	2760–ND001

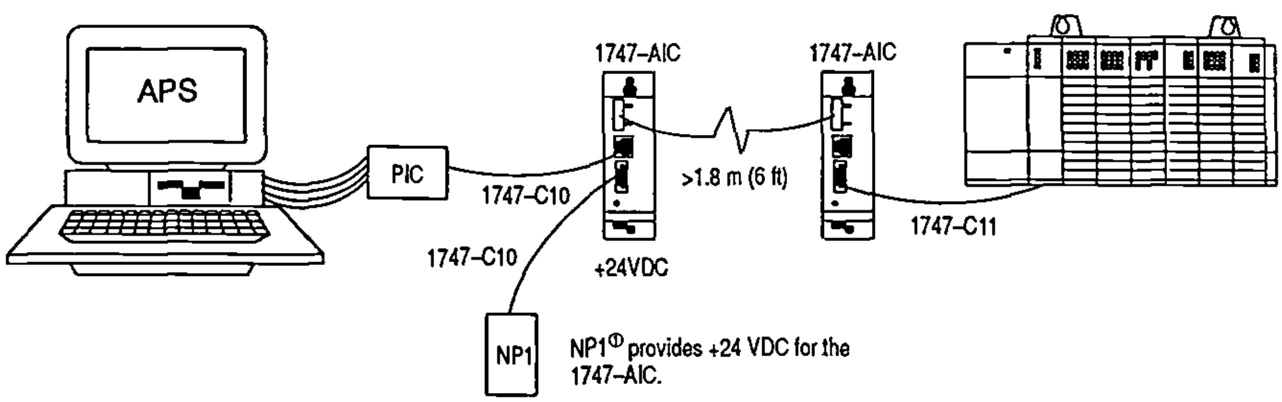
1747-AIC Isolated Link Coupler for DH-485

The isolated link coupler (1747-AIC) is used to connect SLC 500 family devices to the DH-485 network (as shown on page A-5). The coupler provides a 6-position removable terminal block for connection to the DH-485 communication cable.

Network connections for the SLC 500 processor are provided by the Catalog Number 1747-C11, 304.8 mm (12 in.) cable supplied with the link coupler. Network connections for peripheral devices, such as the Personal Interface Converter (1747-PIC), Data Table Access Module (1747-DTAM-E), or Hand-Held Terminal (1747-PT1) are provided by the standard Catalog Number 1747-C10 1.8 m (6 ft) cable supplied with each of those devices.

To protect connected devices, the coupler provides 1500 VDC isolation between the communications cable and the attached SLC 500 controller and peripheral devices (PIC, DTAM, or HHT).

The isolated link coupler can also be used to provide connectivity between a peripheral device (APS and PIC, HHT, or DTAM) for distances greater than 1.8 m (6 ft) up to a maximum of 1219 m (4000 ft). Below is an example of a "remote" connection between a computer running APS and an SLC 500 processor.

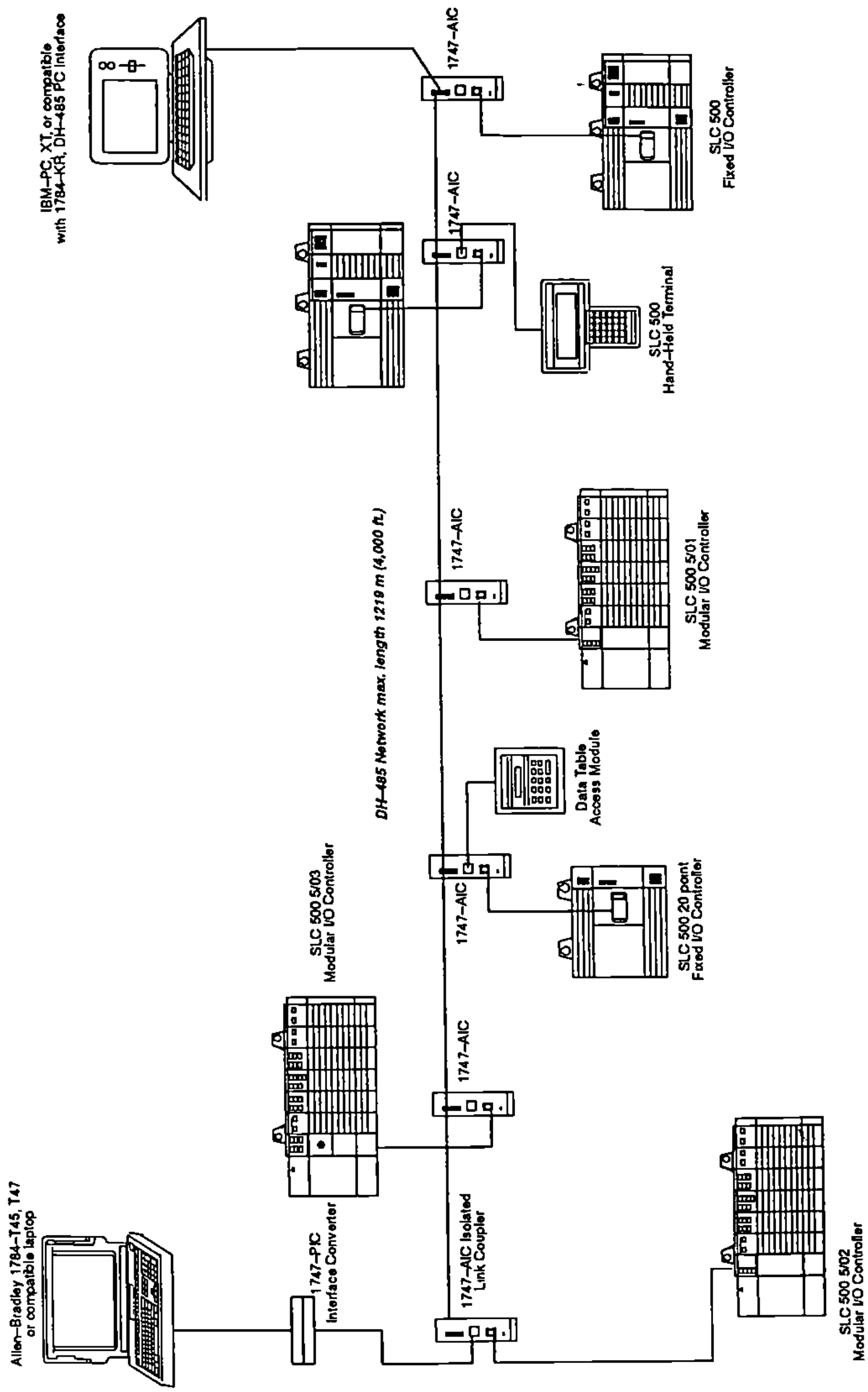


[1] *You can also use an NP2 desktop model*

685 527

Example System Configuration

Below is an example of a DH–485 network.



Important Planning Considerations

Carefully plan your network configuration before installing any hardware. Listed below are some of the factors that can affect system performance:

- amount of electrical noise, temperature, and humidity in the network environment
- number of devices on the network
- connection and grounding quality in installation
- amount of communication traffic on the network
- type of process being controlled
- network configuration

The major hardware and software issues you need to resolve before installing a network are discussed in the following sections.

Hardware Considerations

You need to decide the length of the communication cable, where you route it, and how to protect it from the environment where it will be installed.

When the communication cable is installed, you need to know how many devices are to be connected during installation and how many devices will be added in the future. The following sections will help you understand and plan the network.

Number of Devices and Length of Communication Cable

You must install a link coupler (1747–AIC) for each node on the network. If you plan to add nodes later, provide additional link couplers during the initial installation to avoid recabling after the network is in operation.

The maximum length of the communication cable is 1219 m (4000 ft). This is the total cable distance from the first node to the last node on the network.

Planning Cable Routes

Follow these guidelines to help protect the communication cable from electrical interference:

- Keep the communication cable at least five feet from any electric motors, transformers, rectifiers, generators, arc welders, induction furnaces, or sources of microwave radiation.
- If you must run the cable across power feed lines, run the cable at right angles to the lines.
- If you do not run the cable through a contiguous metallic wireway or conduit, keep the communication cable at least 0.15 m (6 in) from ac power lines of less than 20 A, 0.30 m (1 ft) from lines greater than 20 A, but only up to 100 kVA, and 0.60 m (2 ft) from lines of 100 kVA or more.
- If you run the cable through a contiguous metallic wireway or conduit, keep the communication cable at least 0.08 m (3 in) from ac power lines of less than 20 A, 0.15 m (6 in) from lines greater than 20 A, but only up to 100 kVA, and 0.30 m (1 ft) from lines of 100 kVA or more.

Running the communication cable through conduit provides extra protection from physical damage and electrical interference. If you route the cable through conduit, follow these additional recommendations:

- Use ferromagnetic conduit near critical sources of electrical interference. You can use aluminum conduit in non-critical areas.
- Use plastic connectors to couple between aluminum and ferromagnetic conduit. Make an electrical connection around the plastic connector (use pipe clamps and the heavy gauge wire or wire braid) to hold both sections at the same potential.
- Ground the entire length of conduit by attaching it to the building earth ground.
- Do not let the conduit touch the plug on the cable.
- Arrange the cables loosely within the conduit. The conduit should contain only serial communication cables.
- Install the conduit so that it meets all applicable codes and environmental specifications.

For more information on planning cable routes, see *Industrial Automation Wiring and Grounding Guidelines*, publication number 1770–4.1.

Software Considerations

Software considerations include the configuration of the network and the parameters that can be set to the specific requirements of the network. The following are major configuration factors that have a significant effect on network performance:

- number of nodes on the network
- addresses of those nodes
- baud rate
- maximum node address selection
- *5/03 only*: token hold factor

The following sections explain network considerations and describe ways to select parameters for optimum network performance (speed).

Number of Nodes

The number of nodes on the network directly affects the data transfer time between nodes. Unnecessary nodes (such as a second programming terminal that is not being used) slow the data transfer rate. The maximum number of nodes on the network is 32.

Setting Node Addresses

The best network performance occurs when node addresses start at 0 and are assigned in sequential order. SLC 500 processors default to node address 1. The node address is stored in the processor status file (S:15L). Processors cannot be node 0. Also, initiators such as personal computers should be assigned the lowest numbered addresses to minimize the time required to initialize the network.

If some nodes are connected on a temporary basis, do not assign addresses to them. Simply create nodes as needed and delete them when they are no longer required.

Setting Processor Baud Rate

The best network performance occurs at the highest baud rate, which is 19200. All devices must be at the same baud rate. The default baud rate for SLC 500 devices is 19200. The baud rate is stored in the processor status file (S:15H).

Maximum Node Address Setting

The maximum node address parameter should be set as low as possible. This minimizes the amount of time used in soliciting successors when initializing the network. If all nodes are addressed in sequence from 0, and the maximum node address is equal to the address of the highest addressed node, the token rotation will improve by the amount of time required to transmit a solicit successor packet plus the slot timeout value.

Note that this does not allow any node to be added to the network without affecting the response time. On the other hand, since the time required to hold an open station address is greater than the time required to pass a token, it can be useful to leave a temporary device (such as a personal computer) connected if there is only one such device. (A solicit successor packet requires the same transmission time as the token pass, but there is an added slot timeout period.)

See the *Hand-Held Terminal User Manual*, Catalog Number 1747-NP002, or the *Advanced Programming Software User Manual*, Catalog Number 1747-NM002, for the procedures to set node addresses, processor baud rate, and maximum node addresses.

Important: The SLC 500 Series A (only) processors set the maximum node address to 31 when power is cycled increasing initialization and response time of the network.

685 531

DH–485 Network Installation

To install a DH–485 network, you will need tools to strip the shielded cable and to attach the cable and terminators to the isolated link coupler. Install the DH–485 network using the following tools (or equivalent):

Description	Part Number	Manufacturer
Shielded Twisted Pair Cable	#9842	Belden
Stripping Tool	45–164	Ideal Industries
1/8 " Slotted Screwdriver	NA	NA

DH–485 Communication Cable and Isolated Link Coupler

The link coupler provides a connection for each node. The isolated link coupler electrically isolates the DH–485 communication interface from the processor and peripheral connections. Electrical–optical isolation is provided to 1500 VDC.

The suggested DH–485 communication cable is Belden #9842 cable. The cable is jacketed and shielded with two twisted wire pairs and a drain wire.

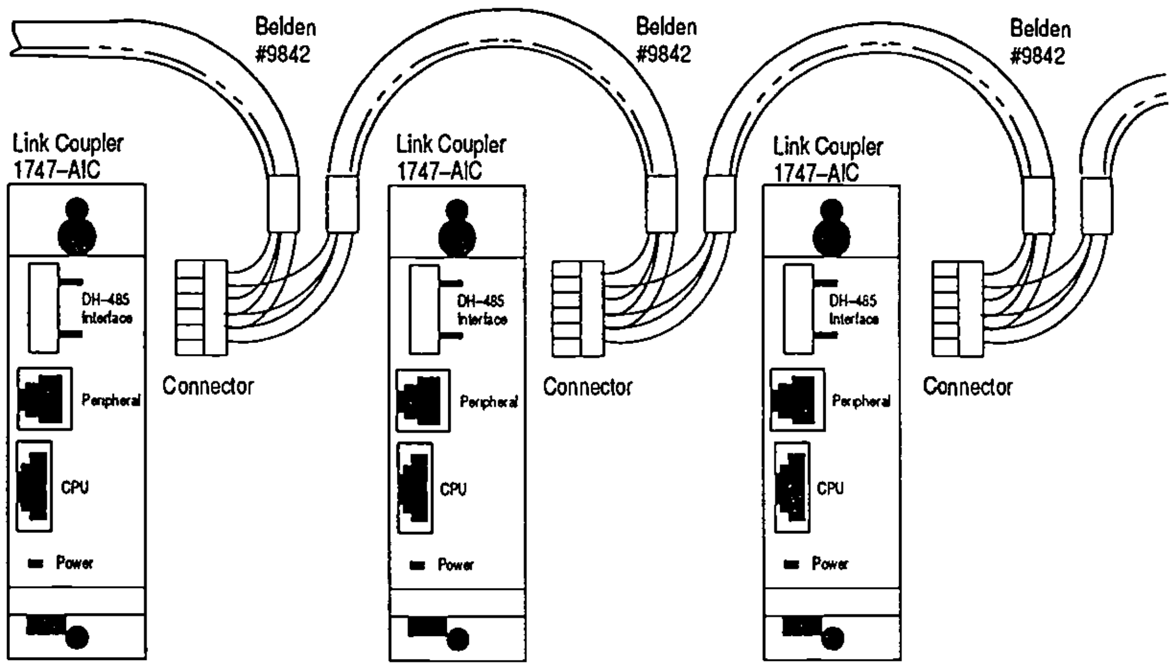
One pair provides a balanced signal line, and one wire of the other pair is used for a common reference line between all nodes on the network. The shield reduces the effect of electrostatic noise from the industrial environment on the network communication.

685 532

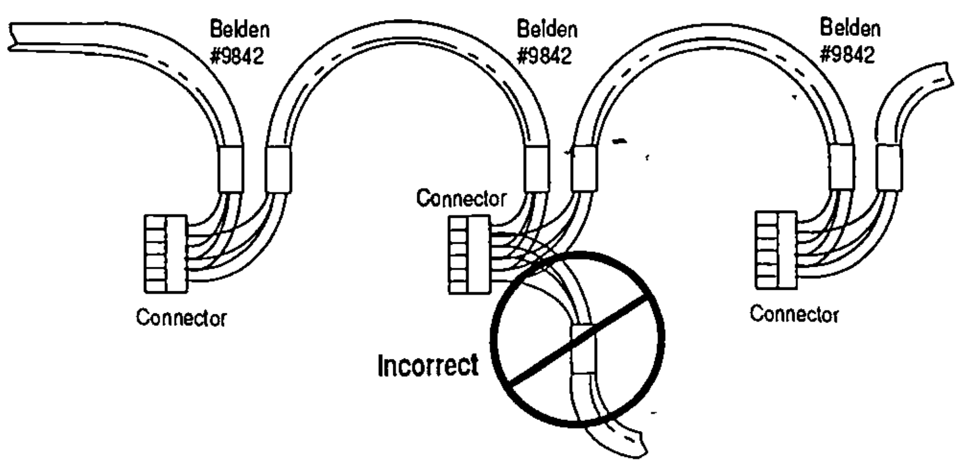
Installing the DH-485 Communication Cable

The communication cable consists of a number of cable segments daisy-chained together. The total length of the cable segments cannot exceed 1219 m (4000 ft).

When cutting cable segments, make them long enough to route them from one link coupler to the next with sufficient slack to prevent strain on the connector. Allow enough extra cable to prevent chafing and kinking in the cable.



Important: We only recommend a network that is daisy-chained. For example, we do *not* recommend the following:

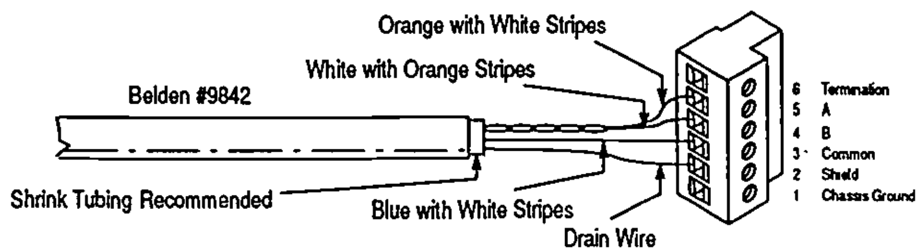


685 533

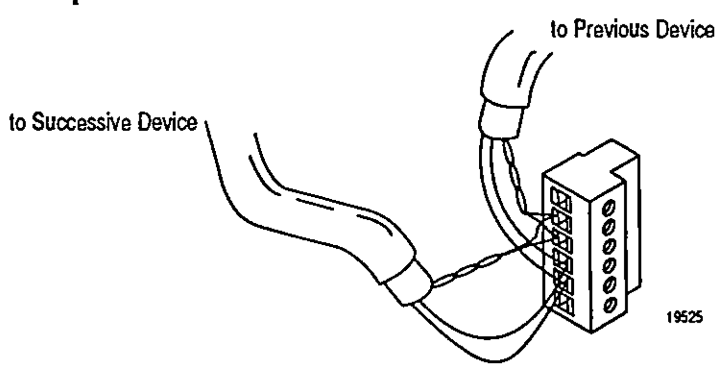
Connecting the Communication Cable to the Isolated Link Coupler

Attach the terminal block of the link coupler to the Belden #9842 cable as shown below. Additional terminal blocks are available for replacement, see chapter 9.

Single Cable Connection



Multiple Cable Connection



685 534

The table below shows wire/terminal connections for DH–485 connectors for *old* Belden #9842.

For this Wire/Pair	Connect this Wire	To this Terminal
Shield/Drain	Non–jacketed	Terminal 2 – Shield
Black/White	Black	Cut back – no connection[1]
	White	Terminal 3 – (Common)
Black/Red	Black	Terminal 4 – (Data B)
	Red	Terminal 5 – (Data A)

[1] *To prevent confusion when installing the communication cable, cut back the black wire immediately after the the insulation jacket is removed. This wire is not used by DH–485*

The table below shows wire/terminal connections for DH–485 connectors for *new* Belden #9842.

For this Wire/Pair	Connect this Wire	To this Terminal
Shield/Drain	Non–jacketed	Terminal 2 – Shield
Blue/White	White with Blue Stripe	Cut back – no connection[1]
	Blue with White Stripe	Terminal 3 – (Common)
White/Orange	White with Orange Stripe	Terminal 4 – (Data B)
	Orange with White Stripe	Terminal 5 – (Data A)

[1] *To prevent confusion when installing the communication cable, cut back the white with blue stripe wire immediately after the the insulation jacket is removed. This wire is not used by DH–485*

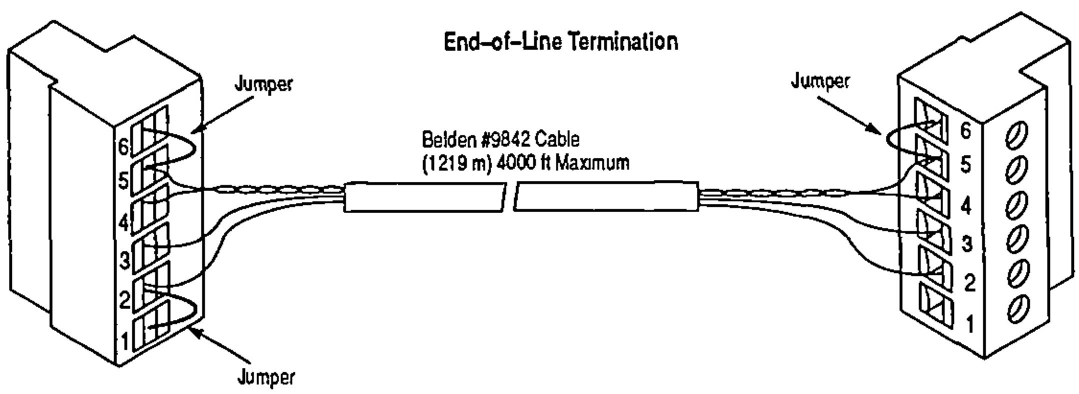
Important: In Series A 1747–AIC, terminal 5 was called DATA B and terminal 4 was called DATA A. In this case, use terminal numbers only and ignore signal names DATA B and DATA A. The internal circuitry of the Series A is the same as Series B.

685 535

Grounding and Terminating the DH–485 Network

One (only one) of the link couplers at the end of the link must have Terminals 1 and 2 of the network connector jumpered together. This provides an earth ground connection for the shield of the communication cable.

Link couplers at both ends of the network must have Terminals 5 and 6 of the link connectors jumpered together. This connects the termination impedance (of 120Ω) that is built into each link coupler as required by the DH–485 specification. See the figure below for the proper jumpering.



685 536

Powering the Link Coupler

In normal operation with the programmable controller connected to the link coupler, the processor powers both the link coupler and peripheral device (DTAM, PIC, HHT) — if connected — through the C11 cable.

If you do not connect the processor to the link coupler, then use a 24 VDC power supply to power the link coupler and peripheral device. The 1747–AIC requires 85mA at 24 VDC. With a peripheral device connected, the total current required is 190mA at 24 VDC.

If both the processor and external power are connected to the link coupler, only the external source is used.

Important: Always connect the CHS GND (chassis ground) terminal to the nearest earth ground. This connection must be made whether or not an external 24 VDC supply is used.

Below are three options for externally powering the 1747–AIC:

- If the link coupler is to be installed in an office environment, you can use the wall mount power supply (1747–NP1) or global desktop power supply (1747–NP2). The link coupler would be powered through either the 1747–C10 cable or by hardwiring from the supply to the screw terminals on the link coupler.
- If you use the AC chassis power supplies (1746–P1 or 1746–P2), you can use the 24 VDC user power supply (200mA maximum) built into the power supply. The link coupler would be powered through a hard–wired connection from the screw terminals on the power supply to the screw terminals on bottom of the link coupler.
- You can use an external DC power supply with the following specifications:
  - operating voltage: 24 VDC ± 25%
  - output current: 190mA
  - rated NEC

  The link coupler would be powered through a hard–wired connection from the external supply to the screw terminals on the bottom of the link coupler.

ATTENTION: If you use an external power supply, it must be 24 VDC. Permanent damage will result if miswired with the wrong power source.

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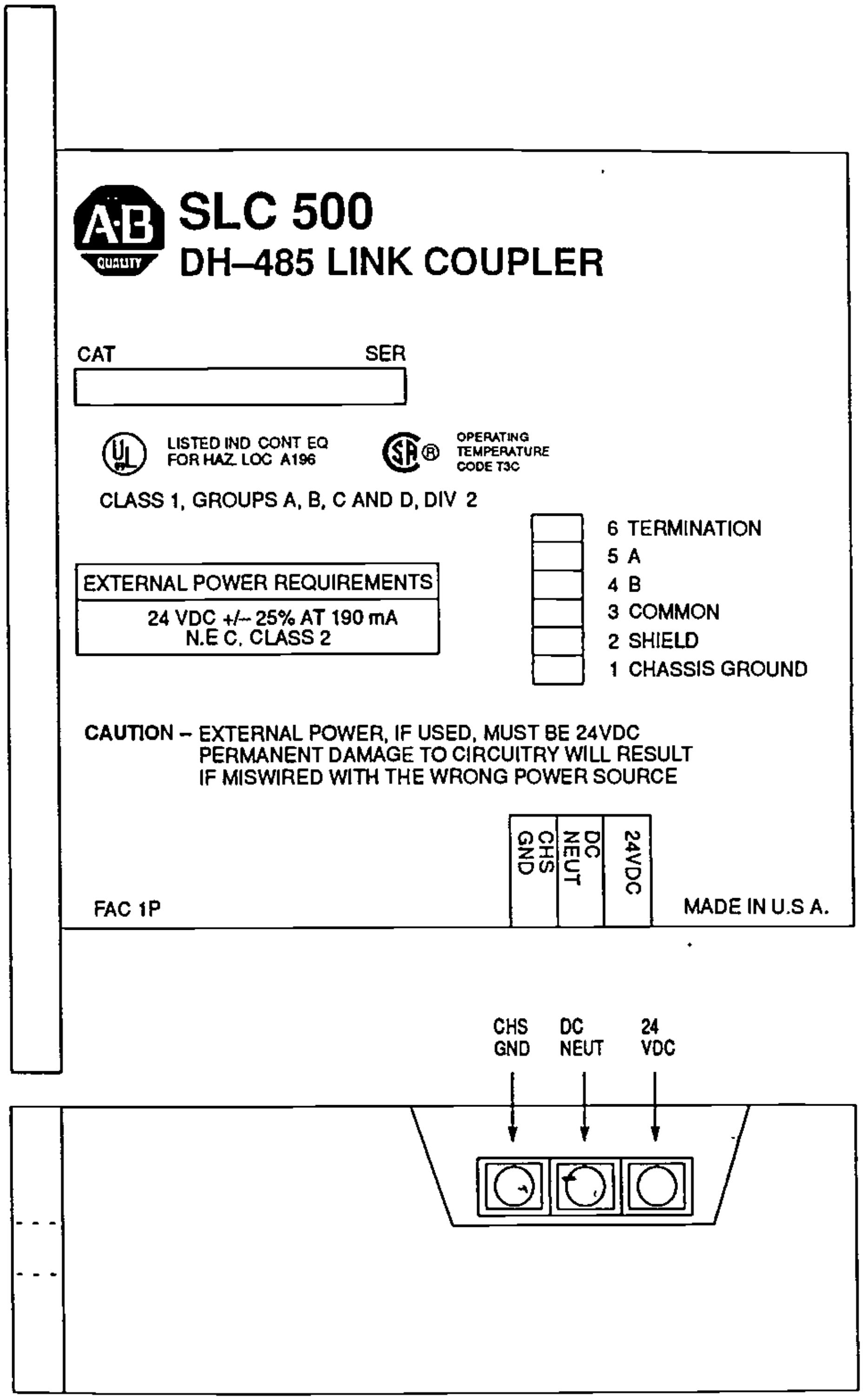
685 537

The figure below shows the external wiring connections and specifications of the link coupler.



Left Side

Bottom

You can connect an unpowered link coupler to the DH–485 network without disrupting network activity. In addition, if an SLC 500 controller powers a link coupler that is connected to the DH–485 network, network activity will not be disrupted should the SLC 500 controller be removed from the link coupler.

Installing and Attaching the Link Couplers

1. Take care when installing the link coupler in an enclosure so that the cable connecting the SLC 500 controller to the link coupler does not hit the enclosure door.
2. Carefully plug the terminal block into the DH–485 port on the link coupler you are putting on the network. Allow enough cable slack to prevent stress on the plug.
3. Provide strain relief for the Belden #9842 cable after it is wired to the terminal block. This guards against breakage of the Belden cable wires.

685 539

Appendix **B**

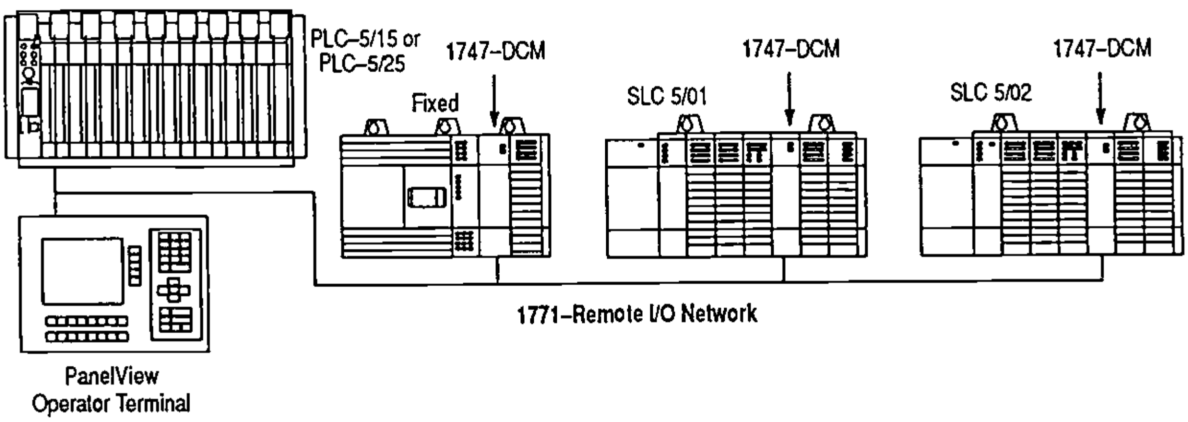
The 1771–Remote I/O Network

This appendix provides a brief introduction about the 1771–Remote I/O Network. For information on the 1771–Remote I/O Network, see the *Direct Communication Module User Manual,* Catalog Number 1747–NM007 and the *Remote I/O Scanner User Manual,* Catalog Number 1747–NM005.

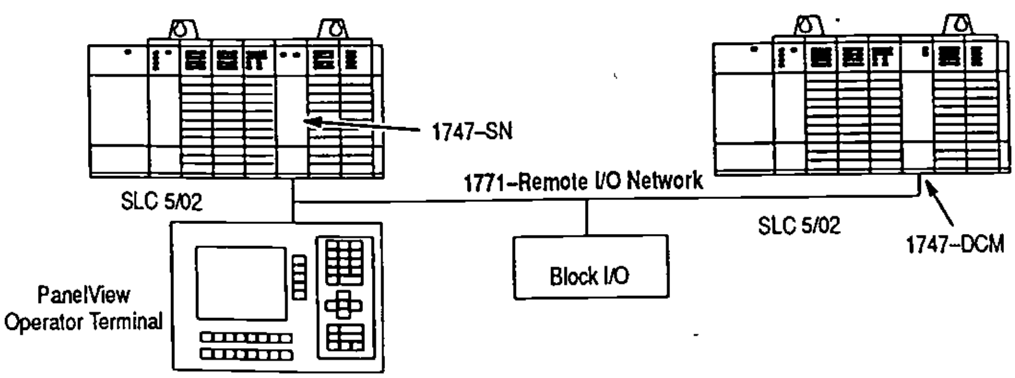
1771–Remote I/O Network

The Allen–Bradley 1771–Remote I/O Network enables chassis of I/O, operator interface terminals, push–button panels, blocks of I/O, message displays, drives and much more to be great distances from the host PLC processor. The SLC 500 controller (fixed, 5/01, 5/02, or 5/03) can interface to this network through the 1747–DCM module for distributed processing. The DCM allows the SLC 500 to look like another device on the network.

Below is an example of the 1771–Remote I/O Network.



With the SLC 5/02 or 5/03 processor, a 1747–SN Remote I/O Scanner can be used as the host of the remote I/O network. With a SLC 5/02 or 5/03 and SN, a PLC is not required on the network.



Appendix C

RS–232 Communication Interface

This appendix provides an overview of the RS–232 communication interface. This appendix also provides information on the following:

- RS–232 and SCADA applications
- RS–232 communication interface overview
- SLC 500 devices that support RS–232 communication
- wiring connectors for RS–232 communication

RS–232 and SCADA Applications

RS–232 is a communication interface included under SCADA (Supervisory Control and Data Acquisition) applications. SCADA is a term that refers to control applications that require communication over long distances. For more information about the use of Allen–Bradley equipment in SCADA applications, refer to the *Allen–Bradley SCADA Applications Guide,* Publication Number ICCG–11.6.

RS–232 Communication Interface Overview

RS–232 is an Electronics Industries Association (EIA) standard that specifies the electrical, mechanical, and functional characteristics for serial binary communication. It provides you with a variety of system configuration possibilities that differ from those offered by DH–485.

One of the biggest benefits of RS–232 communication is that it lets you integrate telephone and radio modems into your control system. The distance over which you are able to communicate with certain system devices is virtually limitless.

The SLC and PLC products detailed in this appendix that communicate over the RS–232 communication interface also use the DF1 serial communication protocol. DF1 protocol delimits messages, controls message flow, detects and signals errors, and retries after errors are detected.

SLC 500 Devices that Support RS–232 Communication

The SLC 500 product line has three other modules, aside from the SLC 5/03 processor, that support the RS–232 communication interface. They are the DH–485 Communication Interface (1770–KF3), the BASIC module (1746–BAS), and the DH–485/RS–232C Interface (1747–KE). All three of these modules can be used with SLC 500 Fixed Controller.

1770–KF3 Module

The 1770–KF3 module links host computers with the Allen–Bradley DH–485 Data Highway. The host computer communicates with the 1770–KF3 over an RS232 link using DF1 protocol. Through the 1770–KF3, the host computer can communicate with the nodes on the DH–485 network.

For more information on the 1770–KF3 module, see the *DH–485 Communication Interface User Manual*, Catalog Number 1770–6.5.18.

1747–KE Module

The 1747–KE is a communication interface module that acts as a bridge between DH–485 networks and devices requiring DF1 protocol. You can configure the DF1 port on the 1747–KE for RS–232/423, RS–422, or RS–485 devices. Residing in an SLC 500 chassis, the 1747–KE is ideally used as an interface module, linking remote DH–485 networks via a modem to a central host.

For more information on the 1747–KE module, see the *DH–485/RS–232 Interface Module User Manual*, Catalog Number 1747–NU001.

1746–BAS Module

The 1746–BAS module, which is programmed using the BASIC language, has two configurable serial ports for interfacing to computers, modems, printers, and other RS–232 compatible devices. You can also use it for off–loading complex math routines from an SLC 500 processor; this conserves valuable ladder logic memory.

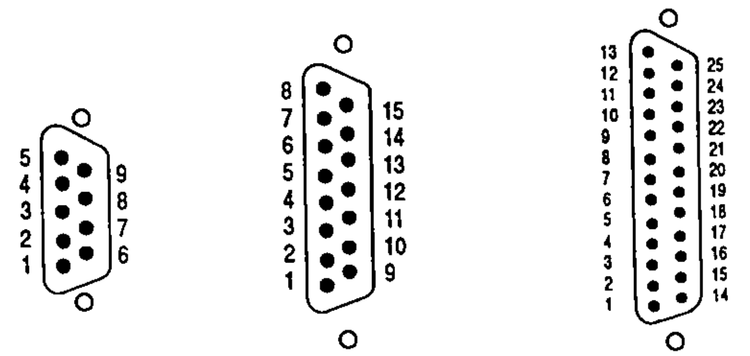
For more information on the 1746–BAS module, see the *SLC 500 BASIC Module Design and Integration Manual*, Catalog Number 1746–ND005.

Wiring Connectors for RS-232 Communication

To connect Allen-Bradley devices with other devices over RS-232, you must wire the cable connectors so that communication can occur through the cabling, which provide the interface between devices.

Types of RS-232 Connectors

The figure below shows male connectors, and their pinout locations, for Allen-Bradley modules.



9-point Connector (Male)   15-point Connector (Male)   25-point Connector (Male)

DTE Pinout

Channel 0, which the 5/03 processor has, is configured as DTE. The pinouts are the same as the 9-pin AT port.

DTE 9 pinout		Signal is	Equivalent DTE 15 pinout	Equivalent DTE 25 pinout
1 –DCD	Data Carrier Detect	Input	8	8
2 –RXD	Received Data	Input	3	3
3 –TXD	Transmitted Data	Output	2	2
4 –DTR	Data Terminal Ready	Output	11	20
5 –COM	Common Return (Signal Ground)	Shared	7	7
6 –DSR	Data Set Ready	Input	6	6
7 –RTS	Request to Send	Output	4	4
8 –CTS	Clear to Send	Input	5	5
9 –NC	No Connection	Input		22 RI Ring Indicator

DCE Pinout

Devices such as a modem are DCE. The pinouts on these terminals are wired to interface with DTE.

DCE 9 pinout		Signal is	Equivalent DCE 25 pinout
1 –DCD	Data Carrier Detect	Output	8
2 –RXD	Received Data	Output	3
3 –TXD	Transmitted Data	Input	2
4 –DTR	Data Terminal Ready	Input	20
5 –COM	Common Return (Signal Ground)	Shared	7
6 –DSR	Data Set Ready	Output	6
7 –RTS	Request to Send	Input	4
8 –CTS	Clear to Send	Output	5
9 –RI	Ring Indicator	Output	22

Important: DCE signal names are viewed from a DTE perspective. For example, TXD is a DTE output and also a DCE input.

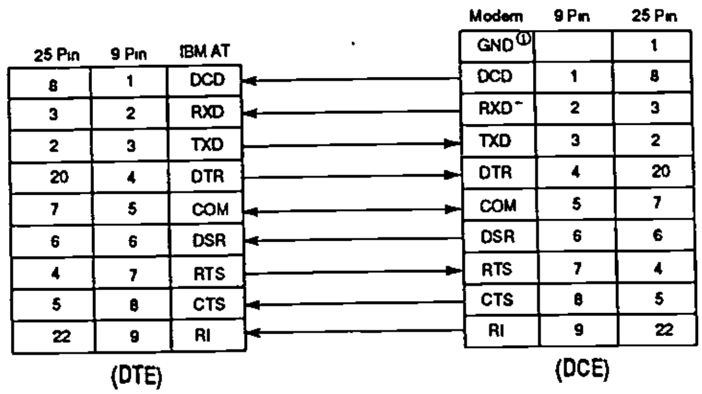
Pin Assignments for Wiring Connectors

Use the following pin assignments to wire the connectors of Allen–Bradley control devices with modems and peripheral devices that support RS–232 communication. See the table below to find the wiring diagram that you need.

To Connect this Device	To this Device	Remarks	See this Page
IBM AT	Modem	Hardware Handshaking Enabled	C–6
	Peripheral DTE	Hardware Handshaking Disabled	C–6
1747–KE	Modem	Hardware Handshaking Enabled	C–7
	Peripheral DTE	Hardware Handshaking Disabled	C–7
1746–BAS	Modem	Hardware Handshaking Enabled	C–8
	Peripheral DTE	Hardware Handshaking Disabled	C–8
1770–KF3	Modem	Hardware Handshaking Enabled	C–8
2760–RB	Modem	Hardware Handshaking Enabled	C–9
	Peripheral DTE	Hardware Handshaking Disabled	C–9
1771–KGM (PLC–2)	Modem	Hardware Handshaking Enabled	C–10
	Peripheral DTE	Hardware Handshaking Disabled	C–10
1775–KA (PLC–3)	Modem	Hardware Handshaking Enabled	C–11
	Peripheral DTE	Hardware Handshaking Disabled	C–11
PLC–5 (channel 0)	Modem	Hardware Handshaking Enabled	C–12
	Peripheral DTE	Hardware Handshaking Disabled	C–12
5130–RM (PLC–5/250)	Modem	Hardware Handshaking Enabled	C–13
	Peripheral DTE	Hardware Handshaking Disabled	C–13

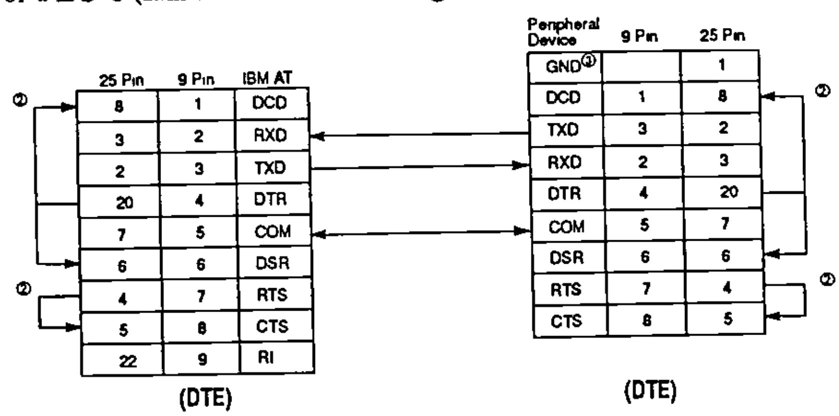
685 545

IBM AT to a Modem (Hardware Handshaking Enabled)



① Connect to the shield of the cable

IBM AT to a 5/03 Processor, 1770–KF3, 1775–KA, 1773–KA, 5130–RM, or PLC–5 (Hardware Handshaking Disabled) ①

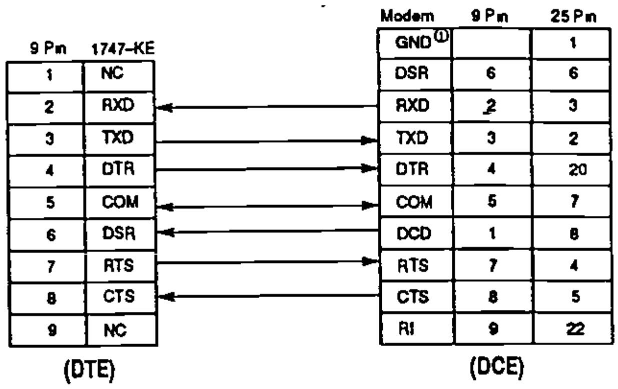


① You can also use cable 1747–CP3

② Jumpers are only needed if you cannot disable the hardware handshaking on the port.

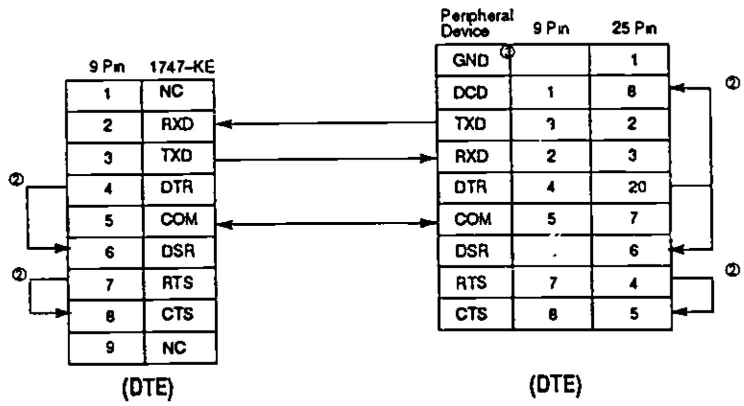
③ Connect to the shield of the cable

1747-KE to a Modem (Hardware Handshaking Enabled)



① Connect to the shield of the cable

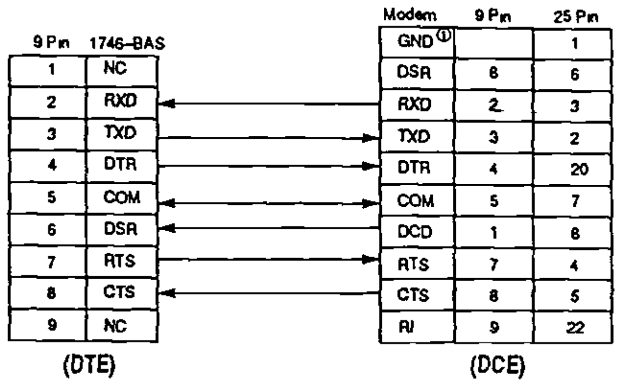
1747-KE to a 5/03 Processor, IBM AT, 1770-KF3, 1775-KA, 1773-KA, 5130-RM, or PLC-5 (Hardware Handshaking Disabled) ①



① You can also use cable 1747-CP3.
② Jumpers are only needed if you cannot disable the hardware handshaking on the port.
③ Connect to the shield of the cable

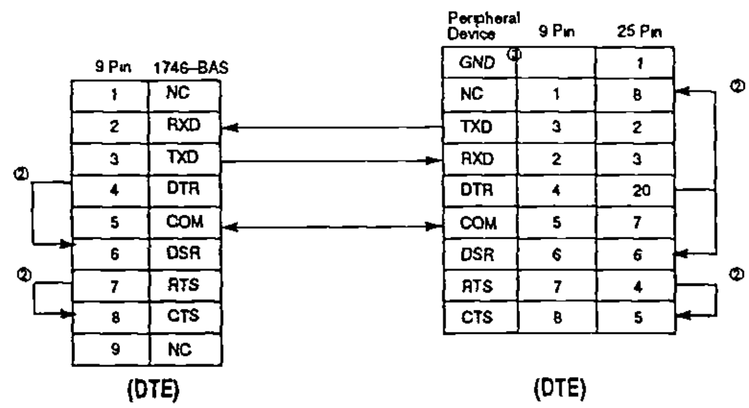
685 547

1746–BAS to a Modem (Hardware Handshaking Enabled)



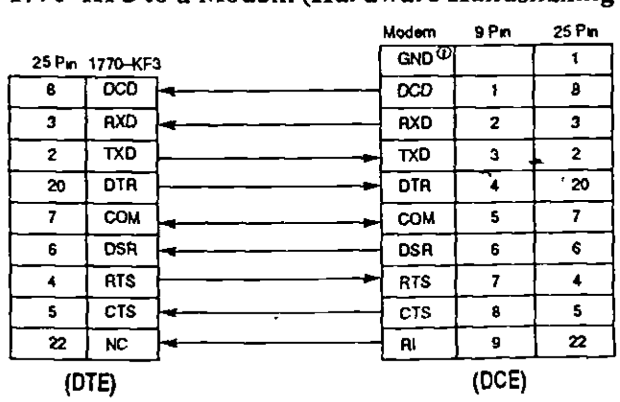
① *Connect to the shield of the cable*

1746–BAS to a 5/03 Processor, IBM AT, 1770–KF3, 1775–KA, 1773–KA, 5130–RM, or PLC–5 (Hardware Handshaking Disabled)①



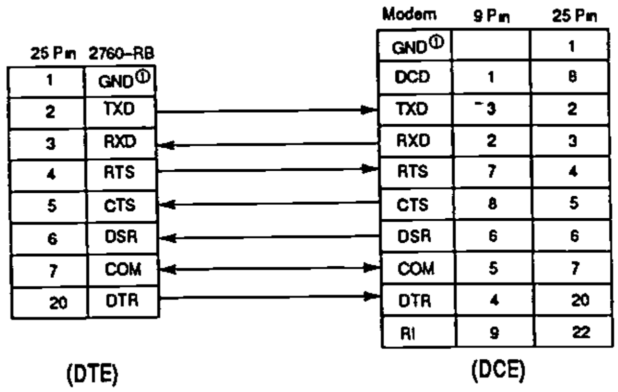
① *You can also use cable 1747–CP3*
② *Jumpers are only needed if you cannot disable the hardware handshaking on the port.*
③ *Connect to the shield of the cable.*

1770–KF3 to a Modem (Hardware Handshaking Enabled)



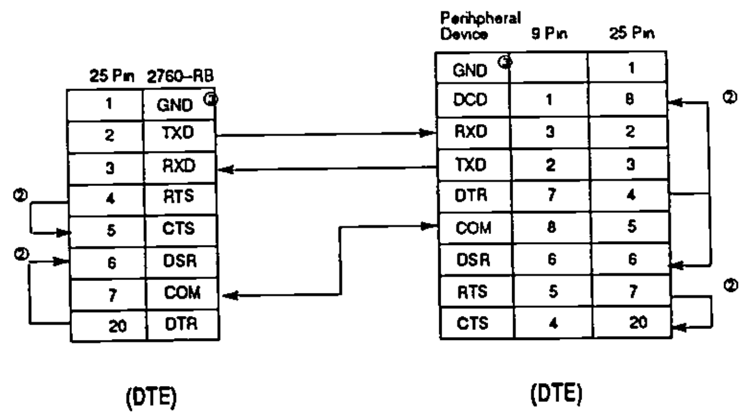
① *Connect to the shield of the cable*

2760–RB to a Modem (Hardware Handshaking Enabled)



① Connect the shield of the cable to the GND pin on one end only Leave the other end open

2760–RB to a 5/03 Processor, IBM AT, 1770–KF3, 1775–KA, 1773–KA, 5130–RM, or PLC–5 (Hardware Handshaking Disabled) ①

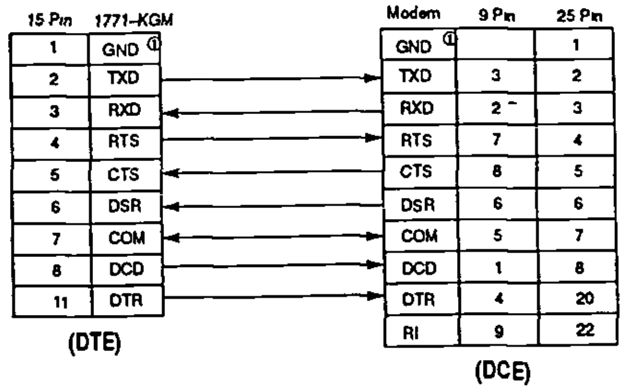


① You can also use cable 1747–CP3.

② Jumpers are only needed if you cannot disable the hardware handshaking on the port.

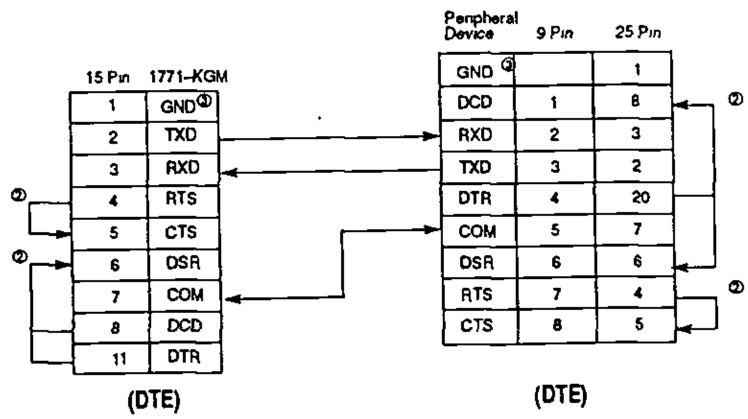
③ Connect the shield of the cable to the GND pin on one end only. Leave the other end open

1771-KGM to a Modem (Hardware Handshaking Enabled)



① Connect the shield of the cable to the GND pin on one end only Leave the other end open

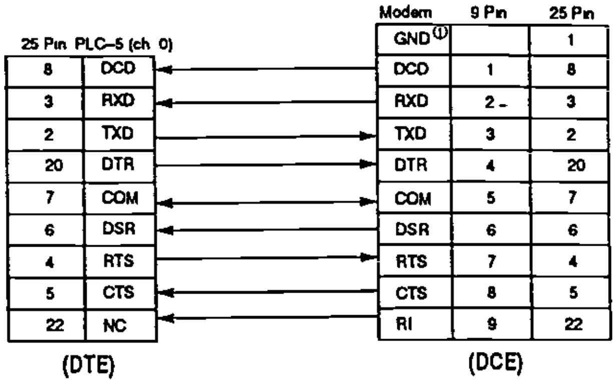
1771-KGM to a 5/03 Processor, IBM AT, 1770-KF3, 1775-KA, 1773-KA, 5130-RM, or PLC-5 (Hardware Handshaking Disabled) ①



① You can also use cable 1747-CP3.
② Jumpers are only needed if you cannot disable the hardware handshaking on the port.
③ Connect the shield of the cable to the GND pin on one end only Leave the other end open

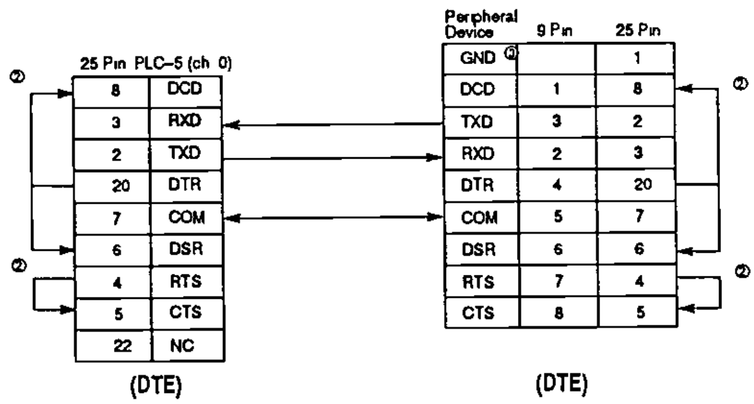
685 550

PLC–5 (Channel 0) to a Modem (Hardware Handshaking Enabled)



① *Connect to the shield of the cable*

PLC–5 (Channel 0) to a 5/03 Processor, IBM AT, 1770–KF3, 1773–KA, 5130–RM, PLC–5, 1747–KE, or 1746–BAS (Hardware Handshaking Disabled) ①

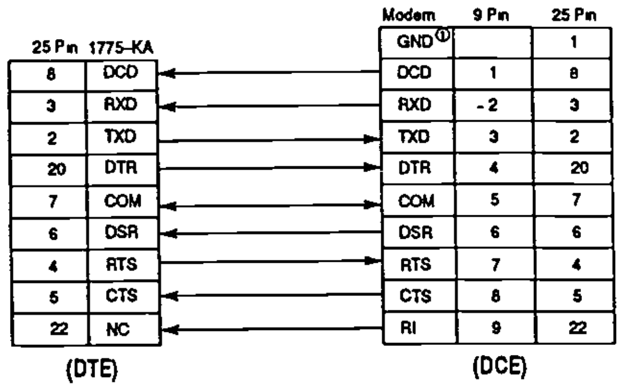


① *You can also use cable 1747–CP3*

② *Jumpers are only needed if you cannot disable the hardware handshaking on the port.*

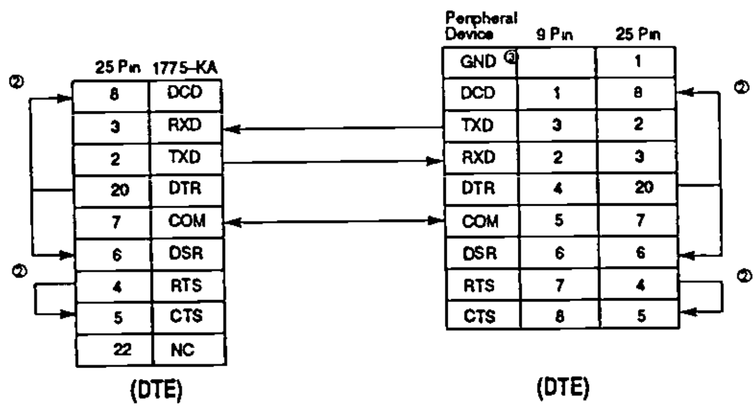
③ *Connect to the shield of the cable*

1775-KA to a Modem (Hardware Handshaking Enabled)



① Connect to the shield of the cable.

1775-KA to a 5/03 Processor, IBM AT, 1770-KF3, 1773-KA, 5130-RM, or PLC-5 (Hardware Handshaking Disabled) ①

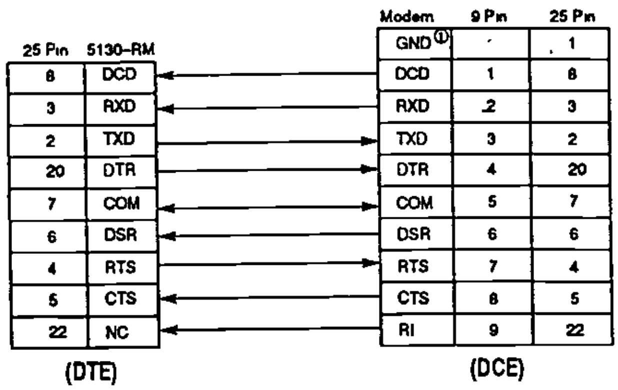


① You can also use cable 1747-CP3

② Jumpers are only needed if you cannot disable the hardware handshaking on the port

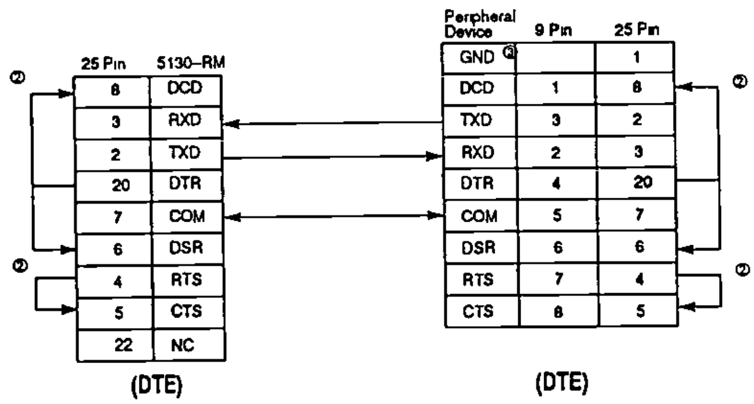
③ Connect to the shield of the cable

5130–RM to a Modem (Hardware Handshaking Enabled)



① Connect to the shield of the cable

5130–RM to a 5/03 Processor, IBM AT, 1770–KF3, 1773–KA, 5130–RM, PLC–5, 1747–KE, or 1746–BAS (Hardware Handshaking Disabled) ①



① You can also use cable 1747–CP3
② Jumpers are only needed if you cannot disable the hardware handshaking on the port
③ Connect to the shield of the cable

685 553

Appendix D

Calculating Heat Dissipation for the SLC 500 Control System

This appendix will assist you in calculating the heat dissipation of your SLC 500 control system. It consists of the following:

- definition of key terms
- table and graphs
- example heat dissipation calculation
- heat dissipation worksheet (page D–5)

To select an enclosure for your SLC 500 control system, refer to chapter 1.

Definition of Key Terms

The following terms are used throughout this appendix. Familiarize yourself with them before proceeding further into the appendix.

Watts per point — maximum heat dissipation that can occur in each field wiring point when energized.

Minimum watts — amount of heat dissipation that can occur when there is no field power present.

Maximum watts — maximum amount of heat that the module generates with field power present.

Module Heat Dissipation: Calculated Watts vs. Maximum Watts

There are two ways that you can calculate heat dissipation.

Calculated Watts — if you want to determine the amount of heat generated by the points energized on your module, use the formula below for calculating the heat dissipation of each module. Then use these values for calculating the heat dissipation of your control system, which is done using the worksheet.

(number of points energized x watts per point) + minimum watts = heat dissipation of module or controller

Maximum Watts — maximum amount of heat that the module generates with field power present. Use maximum watts especially if you are not sure how many points on a module will be energized at any time.

Once you have determined which way you will calculate the heat dissipation of your modules, see the Example Worksheet for Calculating Heat Dissipation on page D–4. This worksheet shows you how to calculate the heat dissipation for the example SLC control system also on page D–4. Once you feel comfortable with the layout of the worksheet, go to the worksheet on page D–5 and fill it out for your control system.

Use this Table to Calculate the Power Supply Loading

Use the table below to calculate the power supply loading for each chassis that you have (step 1 of the worksheet).

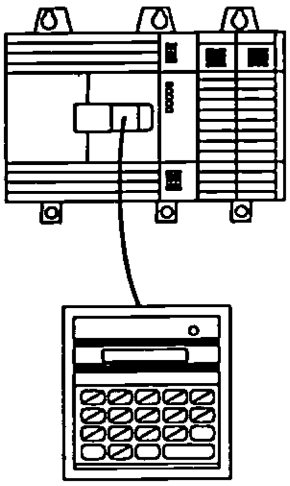
Hardware Component	Catalog Numbers	Watts per Point	Minimum Watts	Maximum Watts
Fixed Controllers	1747–L20A	0.27	10.5	15.0
	1747–L30A	0.27	12 7	19.2
	1747–L40A	0.27	14.3	23.0
	1747–L20B	0.27	9.9	17.0
	1747–L30B	0.27	11.6	22.0
	1747–L40B	0.27	13.0	27.0
	1747–L20C	0.20	17.4	21.0
	1747–L30C	0.20	18.7	24.0
	1747–L40C	0.20	19.9	27.0
	1747–L20D	0.20	12 4	19.0
	1747–L30D	0.20	13.9	23.0
	1747–L20E	0.20	12.6	18.0
	1747–L40E	0.20	16.0	27.0
	1747–L20F	0.20	5 0	9.0
	1747–L40F	0.20	7.4	15.0
	1747–L20G	0.20	4.4	10.0
	1747–L20L	0.20	12.1	18.0
	1747–L30L	0.20	14.0	23 0
	1747–L40L	0.20	16.0	27.0
	1747–L20N	0.20	4 4	10.0
	1747–L20P	0.35	8.8	17.0
	1747–L30P	0.35	10.5	23.0
	1747–L40P	0.35	11 6	28.0
	1747–L20R	0.35	10.5	16 0
Input Modules	1746–IA4	0.27	0.175	1 30
	1746–IA8	0.27	0.250	2.40
	1746–IA16	0.27	0.425	4.80
	1746–IM4	0.35	0.175	1.60
	1746–IM8	0.35	0.250	3.10
	1746–IM16	0.35	0.425	6.00
	1746–IB8	0.20	0.250	1.90
	1746–IB16	0.20	0.425	3.60
	1746–IB32	0.20	0.530	6.90
	1746–IV8	0.20	0.250	1.90
	1746–IV16	0 20	0.425	3.60
	1746–IV32	0.20	0 530	6 90
	1746–IG16	0.020	0.700	1.00
	1746–IN16	0.35	0.425	6.00
Output Modules	1746–OA8	1.00	0 925	9.00
	1746–OA16	0.462	1 85	9.30
	1746–OB8	0.775	0.675	6.90
	1746–OB16	0.338	1.40	7.60
	1746–OB32	0.078	2 26	4 80
	1746–OV8	0.775	0.675	6.90

Hardware Component	Catalog Numbers	Watts per Point	Minimum Watts	Maximum Watts
Output Modules	1746–OV16	0.388	1.40	7.60
	1746–OV32	0.078	2.26	4.80
	1746–OW4	0.133	1.31	1.90
	1746–OW8	0.138	2.59	3.70
	1746–OW16	0.033	5.17	5.70
	1746–OX8	0.825	2.59	8.60
	1746–OG16	0.033	0.900	1.50
Input & Output Modules	1746–IO4	0.27 — per input pt. 0 133 — per output pt.	0.75	1.60
	1746–IO8	0.27 — per input pt. 0 133 — per output pt.	1.38	3.00
	1746–IO12	0.27 — per input pt. 0.133 — per output pt.	2.13	4.60
Specialty Modules	1746–NI4	NA	2.17	2.2
	1746–NIO4I	NA	3.76	3.8
	1746–NIO4V	NA	3.04	3 1
	1746–NO4I	NA	4.96	5.0
	1746–NO4V	NA	3.78	3 8
	1746–BAS	NA	3.75	3 8
	1747–DCM	NA	1.8	1.8
	1747–DSN	NA	4.5	4 5
	1747–KE	NA	3.75	3.8
Peripheral Devices	1747–AIC	NA	2.0	2.0
	1747–DTAM	NA	2.5	2.5
	1747–PT1 Series A & B	NA	2 5	2.5
	1747–PIC	NA	2.0	2 0

NA — Not Applicable

685 556

Example Heat Dissipation Calculation



If your controller consisted of the following hardware components, you would calculate heat dissipation as shown in the *example* worksheet below.

Hardware Components	Catalog Number	Minimum Watts	Maximum Watts
Fixed Controller	1747–L20A	10.5	15.0
Input Module	1746–IA16	0.425	4.8
Output Module	1746–OA16	1.85	9.3
Peripheral Device	1747–DTAM	2.5	2.5

Example Worksheet for Calculating Heat Dissipation

Procedure	Heat Dissipation
1. Calculate the *heat dissipation* for your fixed controller. Write in the watts (calculated watts or maximum watts, see page D–1) dissipated by the controller, I/O and specialty modules, and peripheral device attached to the controller. Add these values together. Catalog Number / Heat Dissipation Fixed Controller: L20A / 15 Expansion Chassis Slot 1 (if applicable): IA16 / 4.8 Slot 2 (if applicable): OA16 / 9.3 Peripheral Device: DTAM / 2.5 Total: 31.6 *Place Total on this Line* ⟶	31.6 W
2. Convert to BTUs/hr. Multiply the total heat dissipation of your SLC 500 fixed control system by 3.414.	x 3.414

Total heat dissipation of the SLC 500 control system: 107.9 BTUs/hr

685, 557

Worksheet for Calculating Heat Dissipation

Use this worksheet to calculate the heat dissipation for your fixed controller.

Procedure	Heat Dissipation
1. Calculate the *heat dissipation* for your fixed controller. Write in the watts (calculated watts or maximum watts, see page D–1) dissipated by the controller, I/O and specialty modules, and peripheral device attached to the controller. Add these values together. Catalog Number / Heat Dissipation Fixed Controller ________ ________ Expansion Chassis Slot 1 (if applicable) ________ ________ Slot 2 (if applicable) ________ ________ Peripheral Device ________ ________ Total: ________ *Place Total on this Line* ——>	________ W
2. Convert to BTUs/hr. Multiply the total heat dissipation of your SLC 500 fixed control system by 3.414.	x 3.414

Total heat dissipation of the SLC 500 control system: ________ **BTUs/hr**

685 558

Appendix E

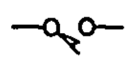
Wiring and Circuit Diagrams and Voltage Ranges for Your Fixed Controller

This appendix covers the following for your fixed controller.

- wiring diagrams
- circuit diagrams
- voltage ranges

Wiring Symbols

The following table provides an explanation of the symbols used in the wiring diagrams. The symbols do not indicate the only type of I/O devices that can be connected, but rather a "typical" device. As long as your I/O device meets the I/O circuit specifications, it should be compatible.

This Symbol	Represents Typical Input Device
	Mechanical switch
	Solid–state switch

This Symbol	Represents Typical Output Device
	Solenoid
	Control relay

The connections illustrated in the wiring diagrams are shown for example purposes only.

- You can connect I/O devices in any order to the I/O circuits. If you are not going to load all of your circuits, space the connections evenly apart to help in heat dissipation.
- All the input circuits on any one fixed controller are the same with one exception: input 0 is unique for all fixed controllers which have 24 VDC input circuits. In this case, input 0 can be used as a high–speed counter. The diagrams in this appendix show the differences in operating characteristics.
- All the output circuits on any one fixed controller are the same.

In the wiring diagrams for the fixed controller with 24 VDC input circuits and 120/240 VAC line power, the User Power Source (terminals next to Power Supply terminals — "PWR OUT 24 VDC" and "PWR OUT COM") is shown to power some input devices. This is optional. The User Power Source can provide up to 200mA at 24 VDC for input devices.

Wiring and Circuit Diagrams and Voltage Range Locations

Use the table below to locate the appropriate wiring and circuit diagrams and voltage ranges.

Catalog Numbers	Description①	Wiring Diagram	Input Circuit Diagram	On/Off State Voltage	Output Circuit Diagram	Operating Voltage Range
1747–L20A	(12) 120 VAC Inputs and (8) Relay Outputs	E–4	E–5	E–5	E–5	E–5
1747–L20B	(12) 120 VAC Inputs and (8) Triac Outputs	E–6	E–7	E–7	E–7	E–7
1747–L20C	(12) 24 VDC Sinking Inputs, High–Speed Counter Input and (8) Relay Outputs	E–8	E–9	E–9	E–10	E–10
1747–L20D	(12) 24 VDC Sinking Inputs, High–Speed Counter Input and (8) Triac Outputs	E–11	E–12	E–12	E–13	E–13
1747–L20E	(12) 24 VDC Sinking Inputs, High–Speed Counter Input and (8) Transistor Sourcing Outputs	E–14	E–15	E–15	E–16	E–16
1747–L20F	(12) 24 VDC Sinking Inputs, High–Speed Counter Input and (8) Relay Outputs	E–17	E–18	E–18	E–19	E–19
1747–L20G	(12) 24 VDC Sinking Inputs, High–Speed Counter Input and (8) Transistor Sourcing Outputs	E–20	E–21	E–21	E–22	E–22
1747–L20L	(12) 24 VDC Sourcing Inputs, High–Speed Counter Input and (8) Transistor Sinking Outputs	E–23	E–24	E–24	E–25	E–25
1747–L20N	(12) 24 VDC Sourcing Inputs, High–Speed Counter Input and (8) Transistor Sinking Outputs	E–26	E–27	E–27	E–28	E–28
1747–L20P	(12) 240 VAC Inputs and (8) Triac Outputs	E–29	E–30	E–30	E–30	E–30
1747–L20R	(12) 240 VAC Inputs and (8) Relay Outputs	E–31	E–32	E–32	E–32	E–32
1747–L30A	(18) 120 VAC Inputs and (12) Relay Outputs	E–33	E–34	E–34	E–34	E–34
1747–L30B	(18) 120 VAC Inputs and (12) Triac Outputs	E–35	E–36	E–36	E–36	E–36
1747–L30C	(18) 24 VDC Sinking Inputs, High–Speed Counter Input and (12) Relay Outputs	E–37	E–38	E–38	E–39	E–39
1747–L30D	(18) 24 VDC Sinking Inputs, High–Speed Counter Input and (12) Triac Outputs	E–40	E–41	E–41	E–42	E–42
1747–L30L	(18) 24 VDC Sourcing Inputs, High–Speed Counter Input and (12) Transistor Sinking Outputs	E–43	E–44	E–44	E–45	E–45
1747–L30P	(18) 240 VAC Inputs and (12) Triac Outputs	E–46	E–47	E–47	E–47	E–47
1747–L40A	(24) 120 VAC Inputs and (16) Relay Outputs	E–48	E–49	E–49	E–49	E–49

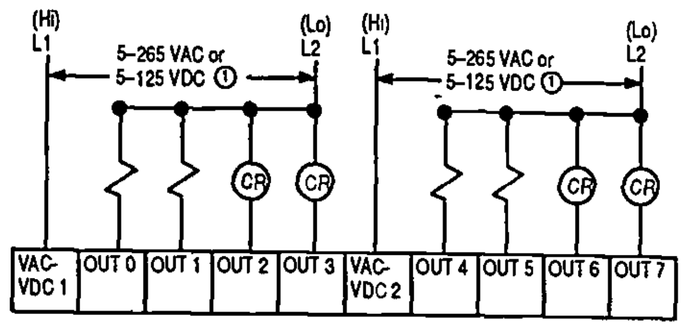
Catalog Numbers	Description[1]	Wiring Diagram	Input Circuit Diagram	On/Off State Voltage	Output Circuit Diagram	Operating Voltage Range
1747-L40B	(24) 120 VAC Inputs and (16) Triac Outputs	E-50	E-51	E-51	E-51	E-51
1747-L40C	(24) 24 VDC Sinking Inputs, High-Speed Counter Input and (16) Relay Outputs	E-52	E-53	E-53	E-54	E-54
1747-L40E	(24) 24 VDC Sinking Inputs, High-Speed Counter Input and (16) Transistor Sourcing Outputs	E-55	E-56	E-56	E-57	E-57
1747-L40F	(24) 24 VDC Sinking Inputs, High-Speed Counter Input and (16) Relay Outputs	E-58	E-59	E-59	E-60	E-60
1747-L40L	(24) 24 VDC Sourcing Inputs, High-Speed Counter Input and (16) Transistor Sinking Outputs	E-61	E-62	E-62	E-63	E-63
1747-L40P	(24) 240 VAC Inputs and (16) Triac Outputs	E-64	E-65	E-65	E-65	E-65

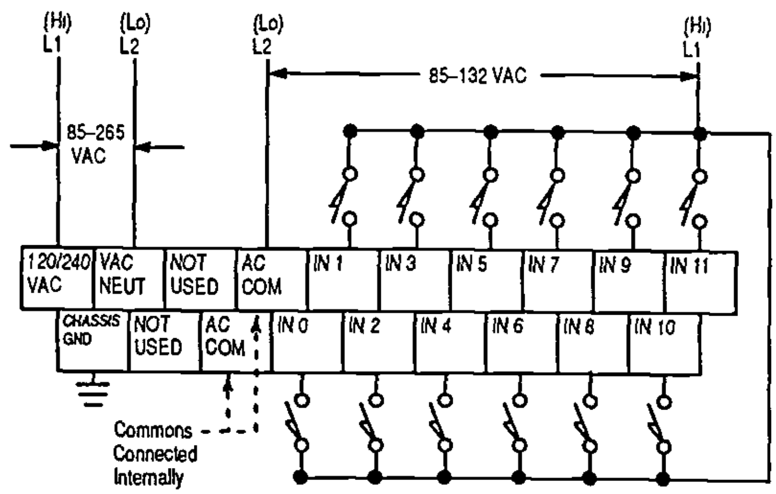
[1] *Refer to page 1-5 for line power specifications*

685 561

Catalog Number 1747–L20A (12) 120 VAC Inputs & (8) Relay Outputs

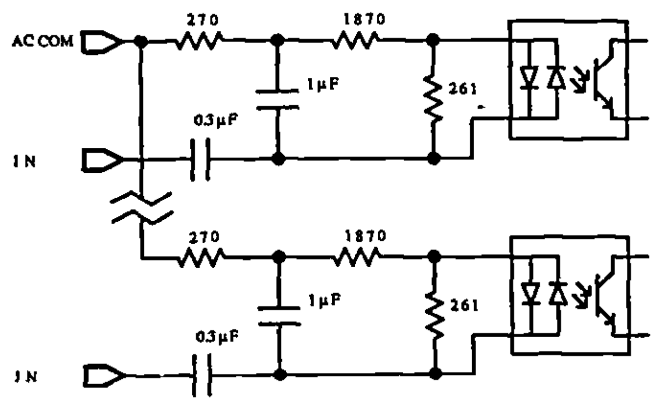
Wiring Diagram



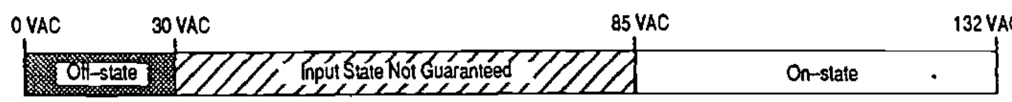


① *The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

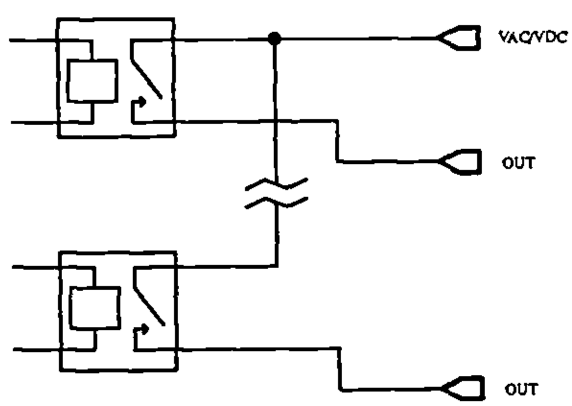
Input Circuit Diagram



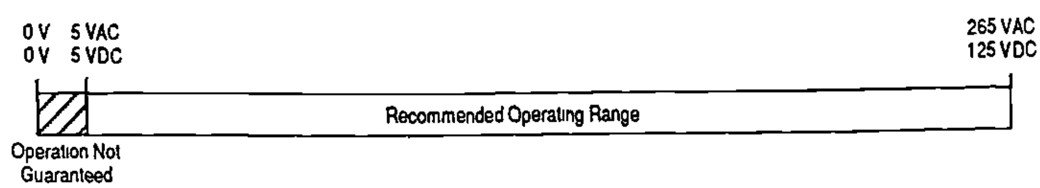
On/Off State Voltage Ranges



Output Circuit Diagram



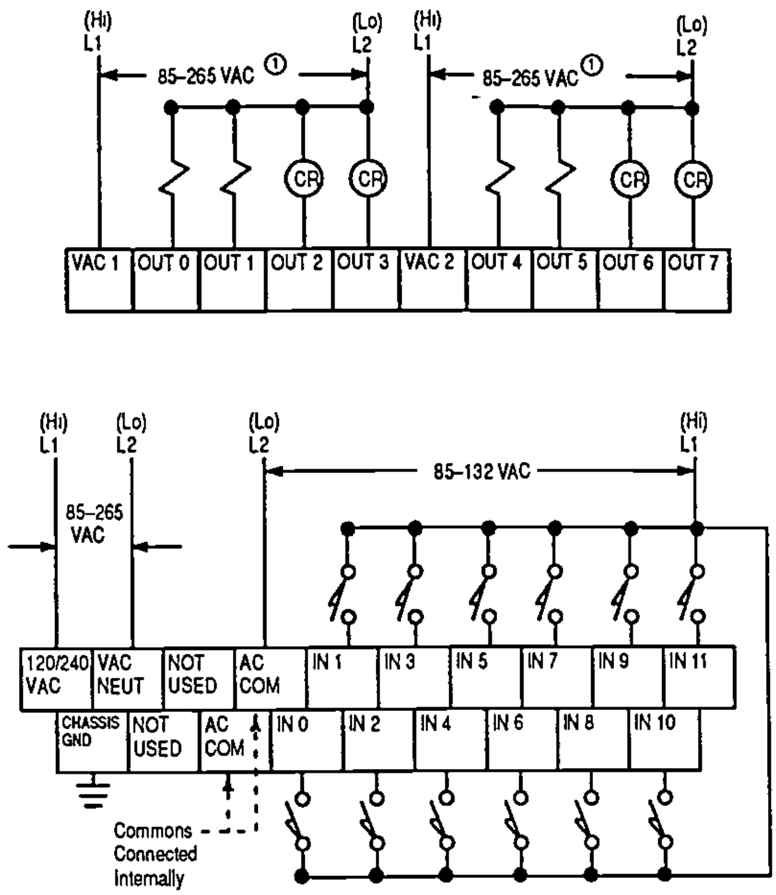
Operating Voltage Range



685 563·

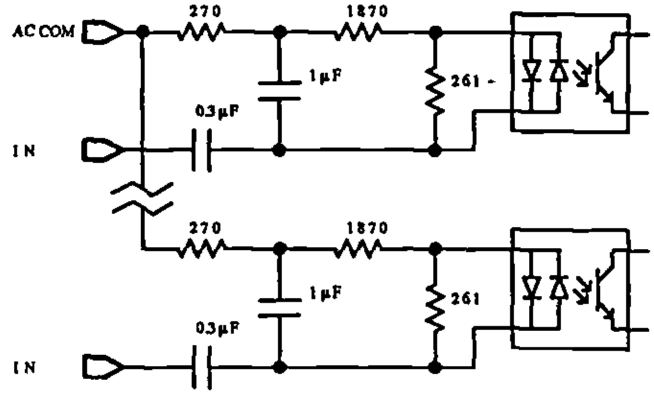
Catalog Number 1747–L20B (12) 120 VAC Inputs & (8) Triac Outputs

Wiring Diagram

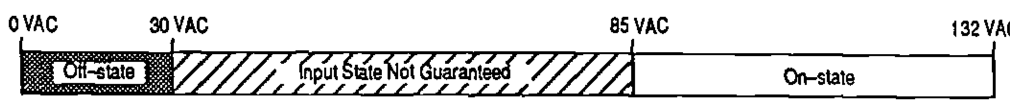


① *The outputs are isolated in groups as shown Therefore, different voltages can be applied to each group as the specific application requires*

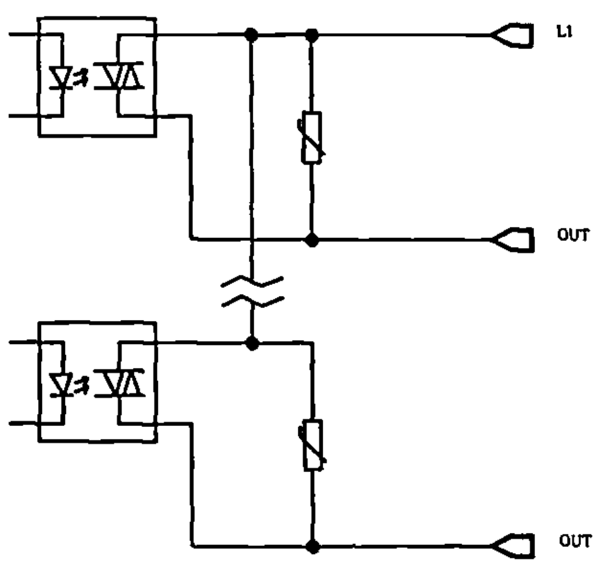
Input Circuit Diagram



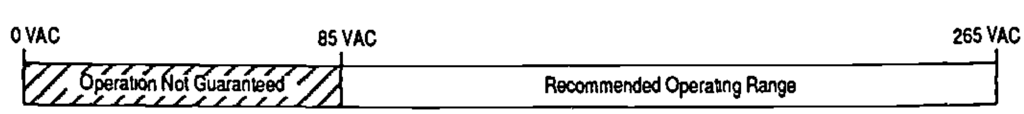
On/Off State Voltage Ranges



Output Circuit Diagram



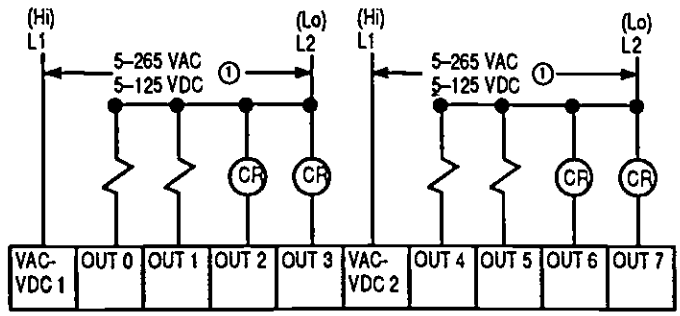
Operating Voltage Range

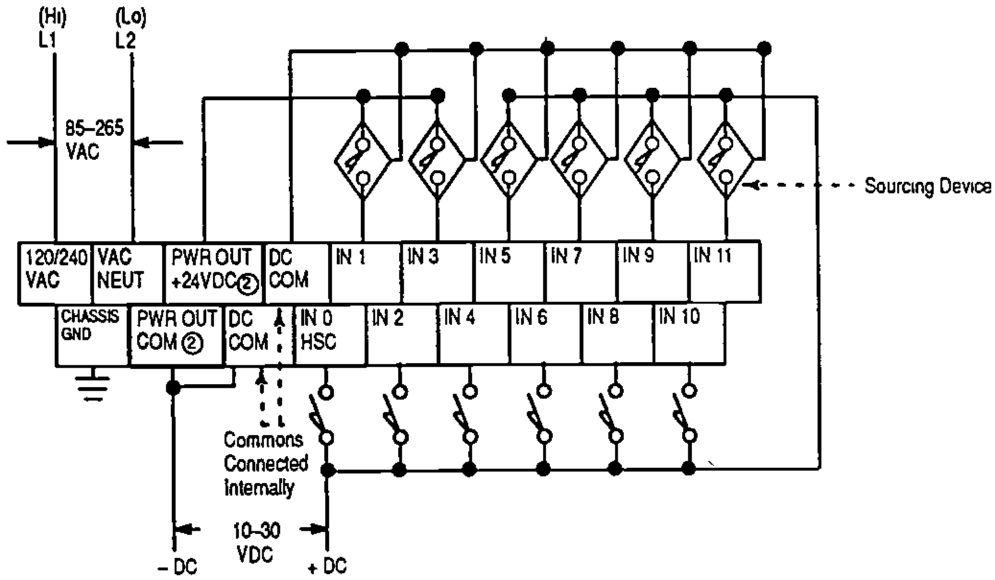


Important: If you measure the voltage at an output terminal that is not connected to a load or is connected to a high–impedance load, you may measure as much as 100 VAC even though the output is off

Catalog Number 1747–L20C (12) 24 VDC Sinking Inputs, High–Speed Counter Input & (8) Relay Outputs

Wiring Diagram

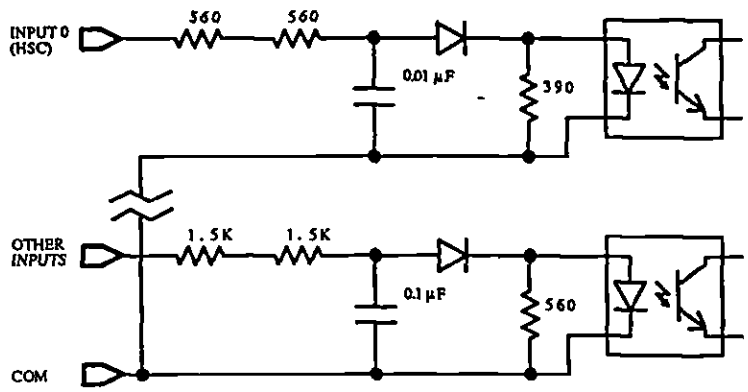




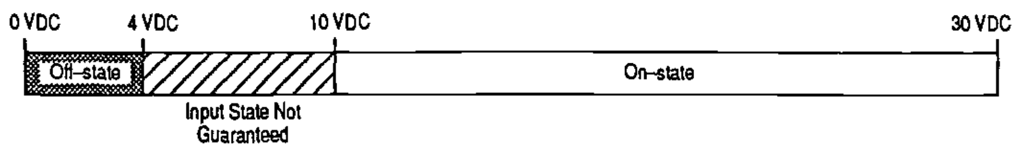
① *The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

② *24 VDC, 200mA user power is available for sensors*

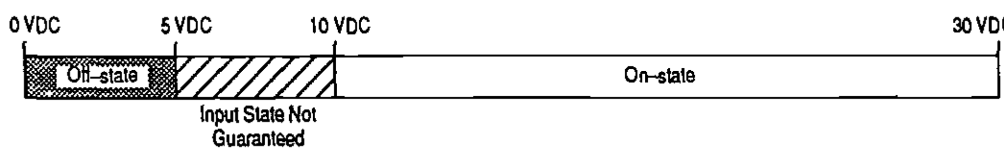
Input Circuit Diagram



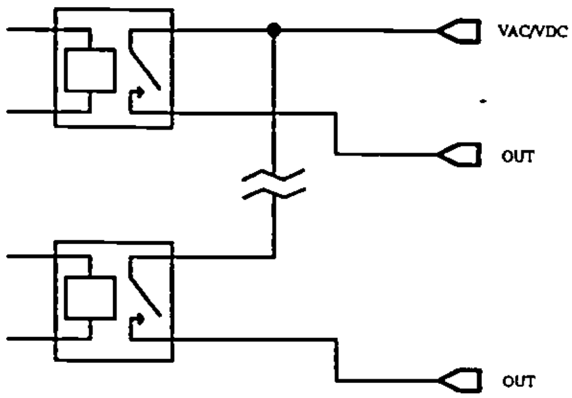
On/Off State Voltage Ranges – Input 0 (HSC)



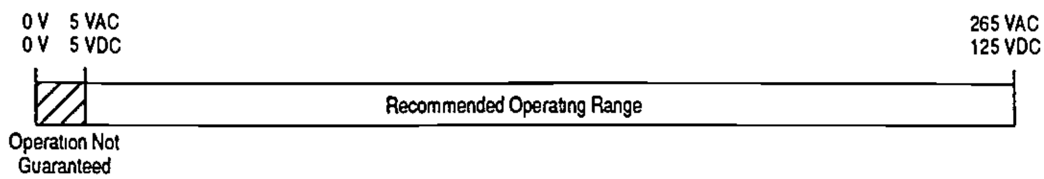
On/Off State Voltage Ranges – All Other Inputs



Output Circuit Diagram

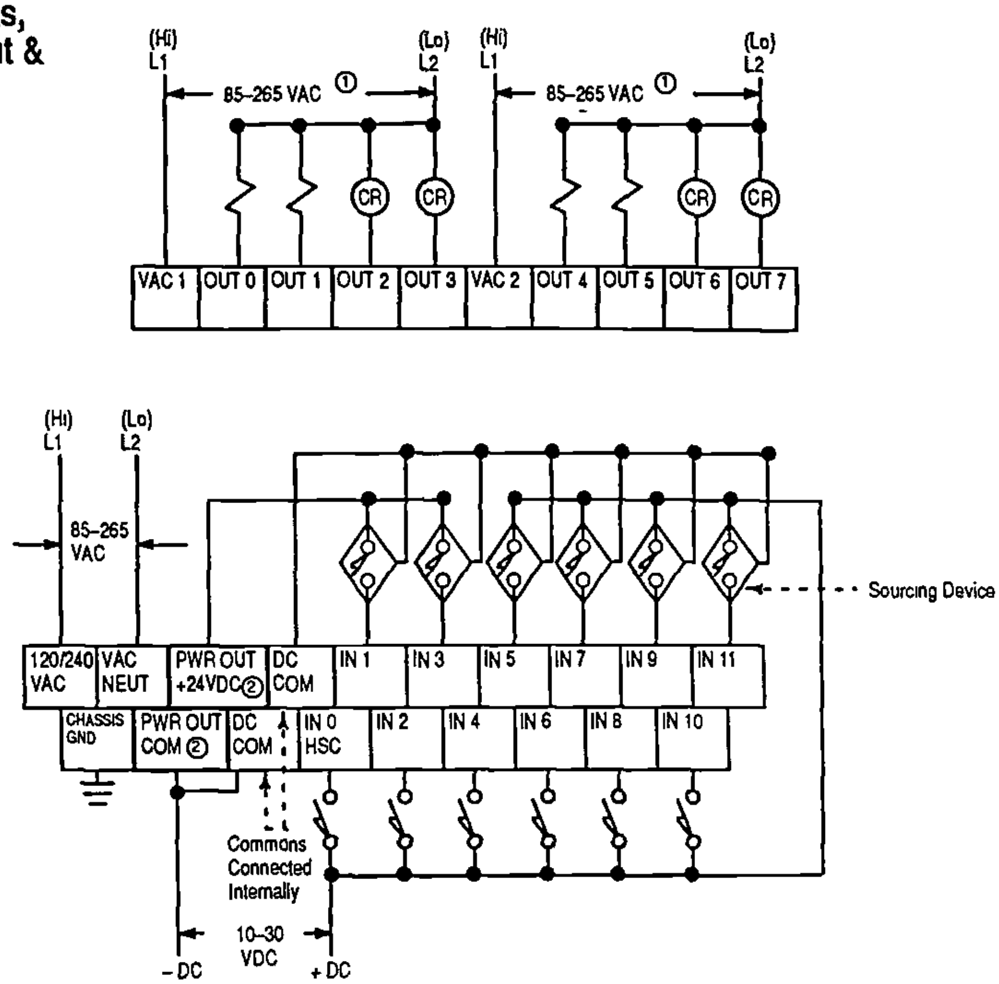


Operating Voltage Range



Catalog Number 1747–L20D (12) 24 VDC Sinking Inputs, High–Speed Counter Input & (8) Triac Outputs

Wiring Diagram

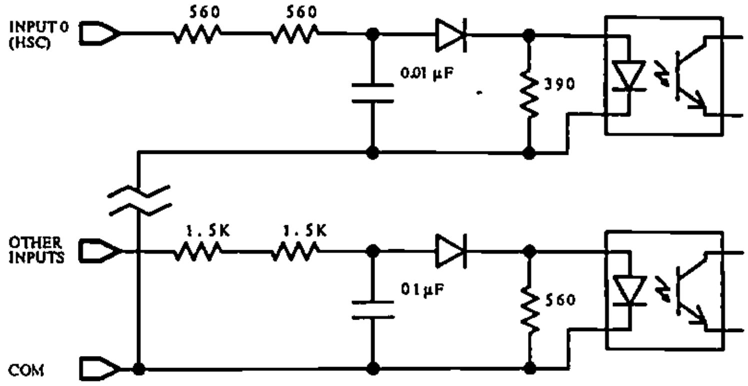


① The outputs are isolated in groups as shown Therefore, different voltages can be applied to each group as the specific application requires

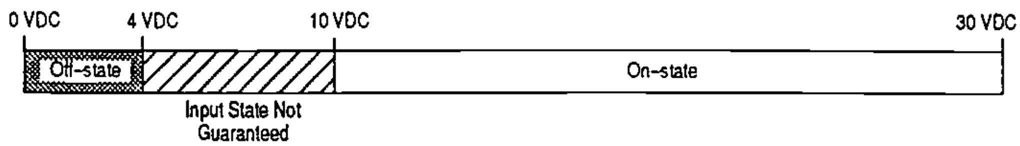
② 24 VDC, 200mA user power is available for sensors

685 569

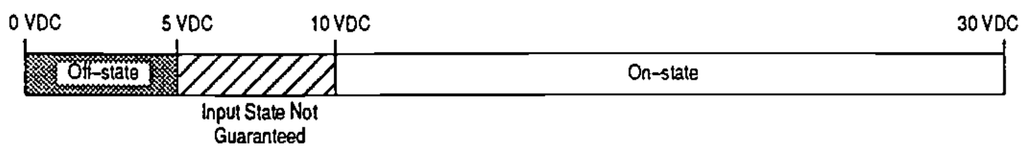
Input Circuit Diagram



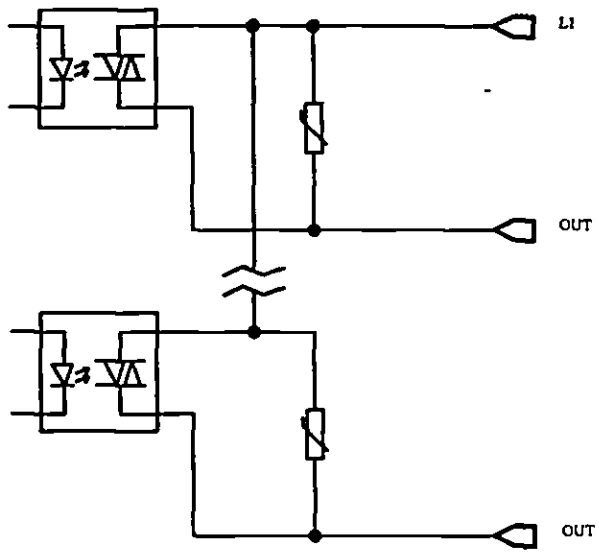
On/Off State Voltage Ranges – Input 0 (HSC)



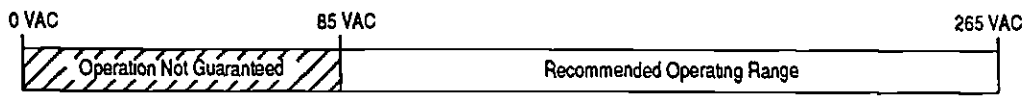
On/Off State Voltage Ranges – All Other Inputs



Output Circuit Diagram



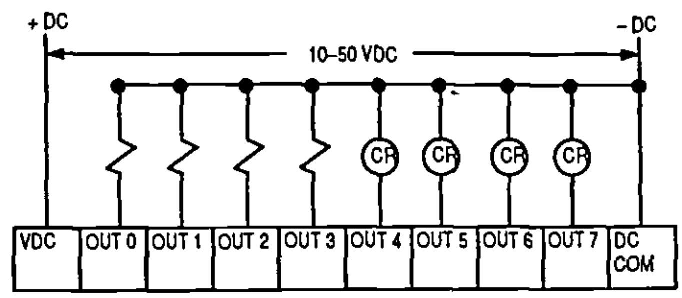
Operating Voltage Range

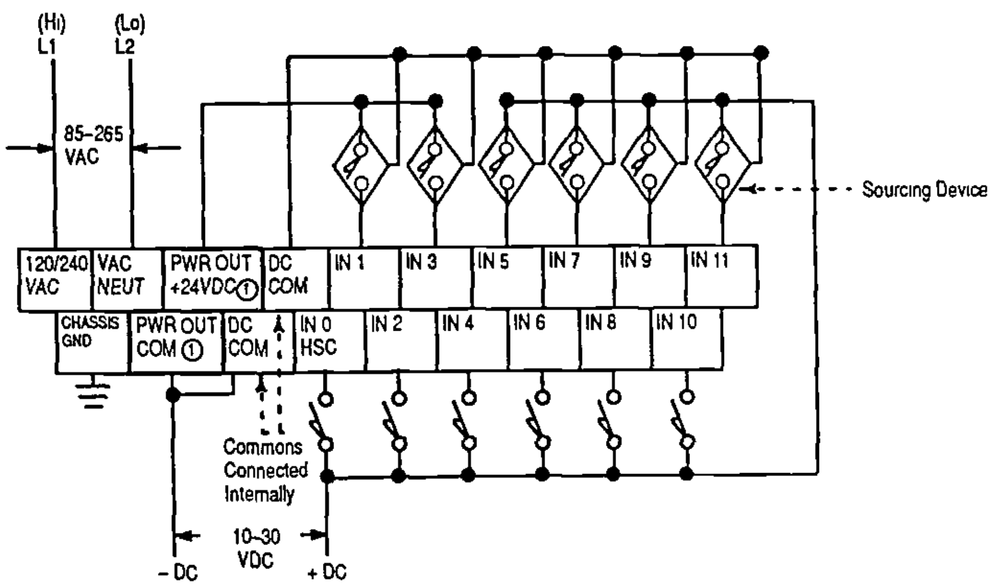


Important: If you measure the voltage at an output terminal that ıs not connected to a load or ıs connected to a high–impedance load, you may measure as much as 100 VAC even though the output ıs off

Catalog Number 1747–L20E (12) 24 VDC Sinking Inputs, High–Speed Counter Input & (8) Transistor Sourcing Outputs

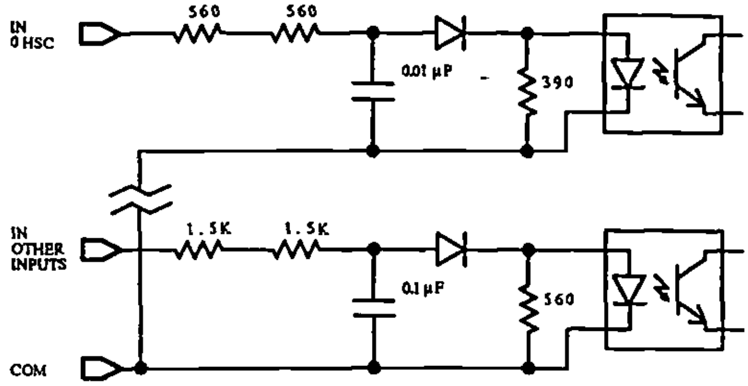
Wiring Diagram



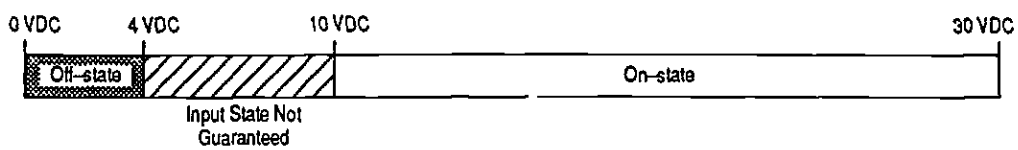


① *24 VDC, 200mA user power is available for sensors*

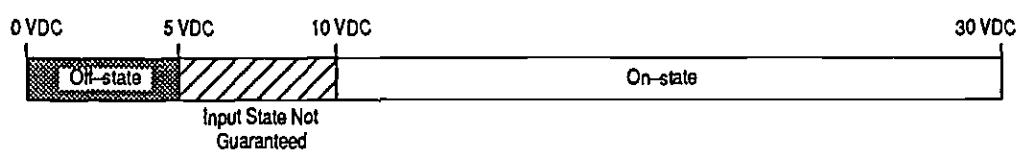
Input Circuit Diagram



On/Off State Voltage Ranges – Input 0 (HSC)

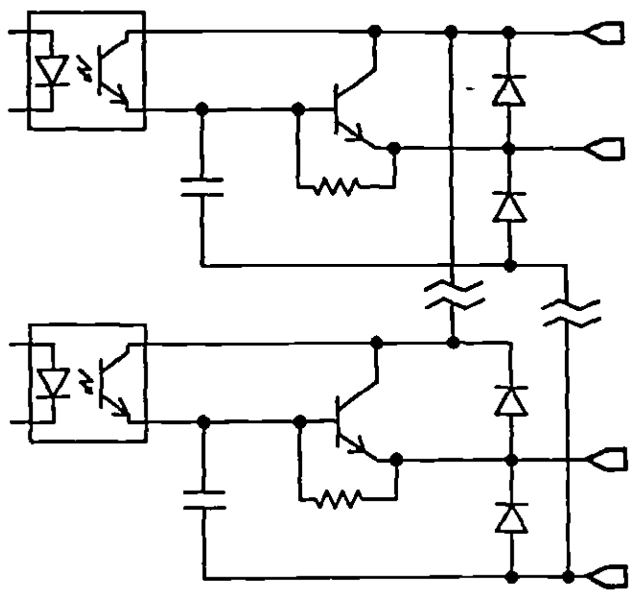


On/Off State Voltage Ranges – All Other Inputs



685 573

Output Circuit Diagram

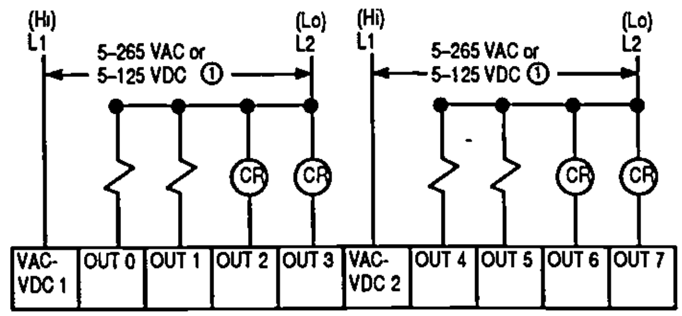


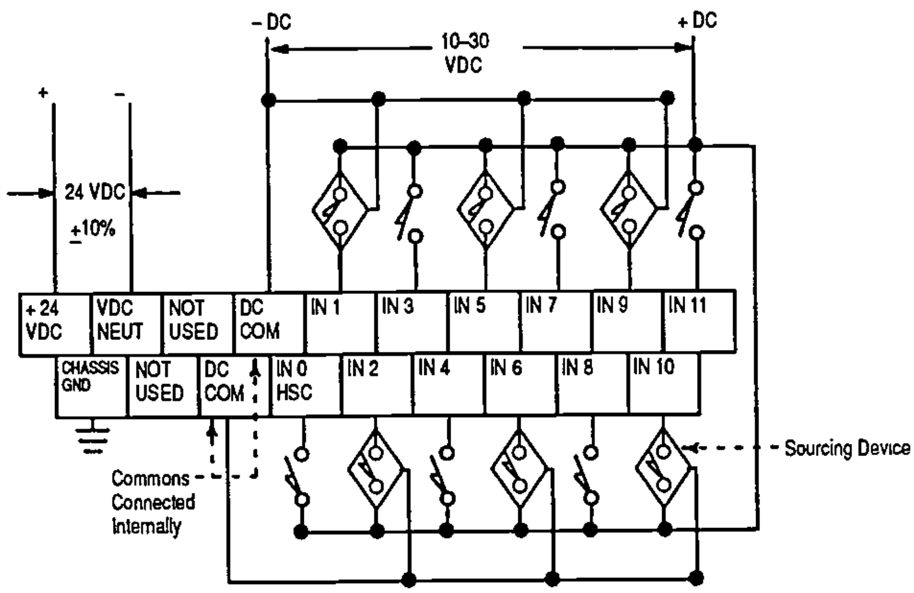
Operating Voltage Range

(Voltage is applied between +VDC and DC common)

Catalog Number 1747–L20F (12) 24 VDC Sinking Inputs, High–Speed Counter Input & (8) Relay Outputs

Wiring Diagram

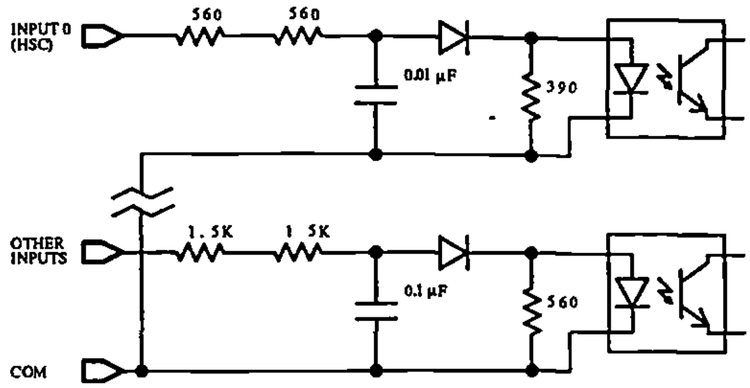




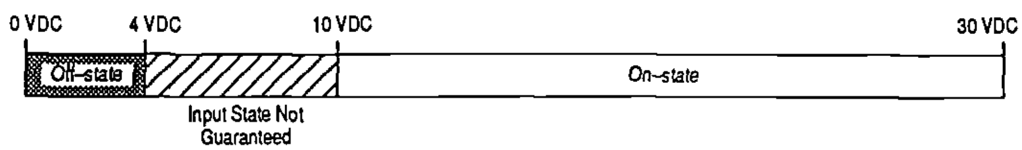
① *The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

685 575

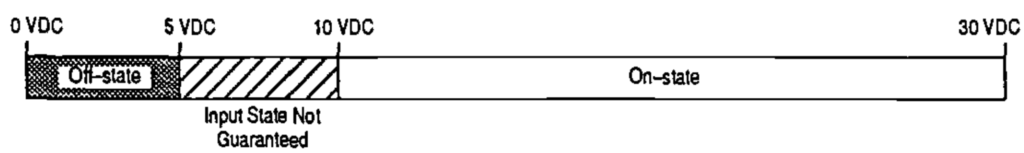
Input Circuit Diagram



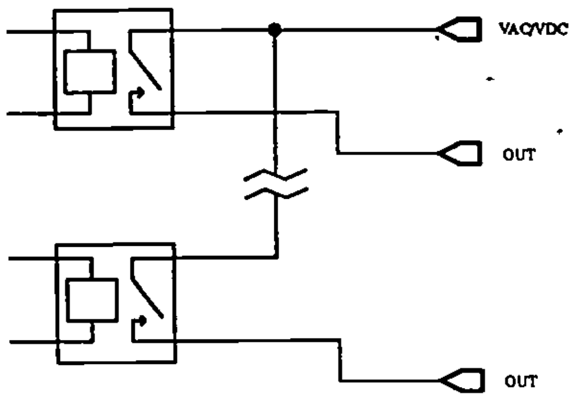
On/Off State Voltage Ranges – Input 0 (HSC)



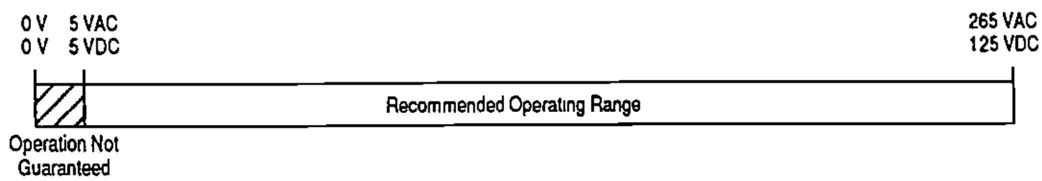
On/Off State Voltage Ranges – All Other Inputs



Output Circuit Diagram



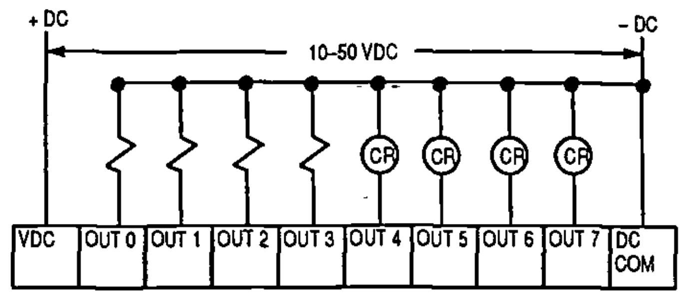
Operating Voltage Range

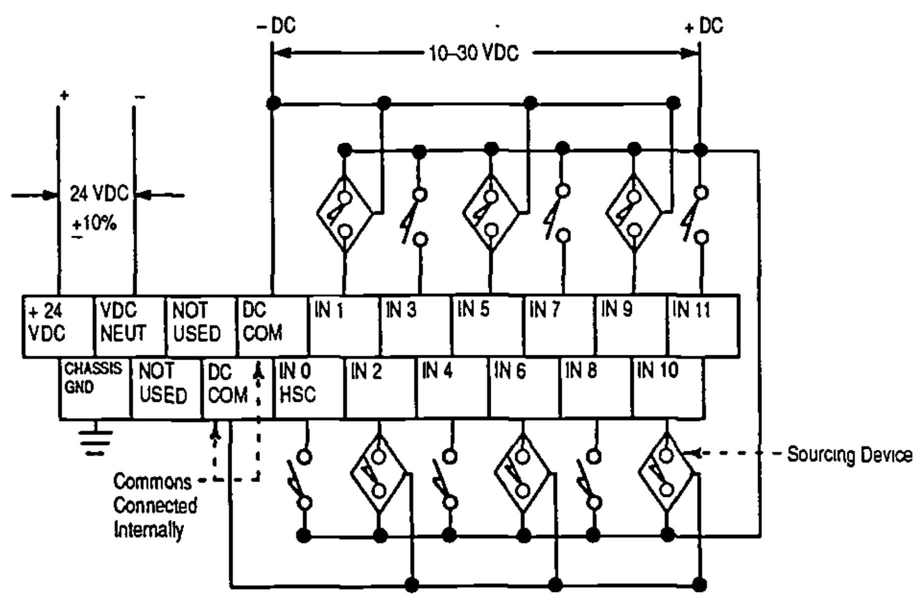


685 577

Catalog Number 1747–L20G (12) 24 VDC Sinking Inputs, High–Speed Counter Input & (8) Transistor Sourcing Outputs

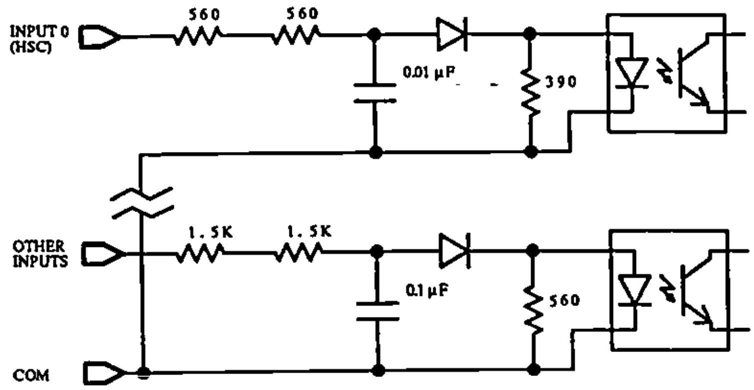
Wiring Diagram



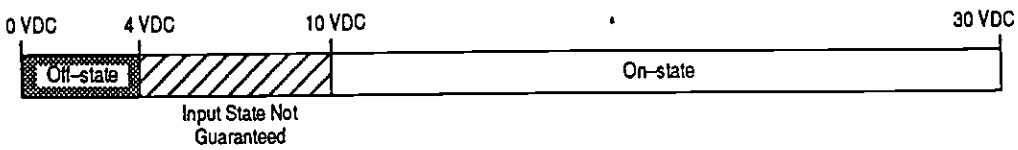


685 578

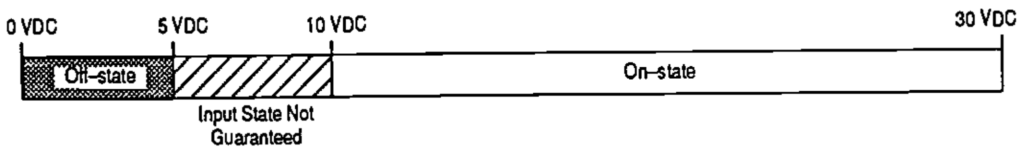
Input Circuit Diagram



On/Off State Voltage Ranges – Input 0 (HSC)

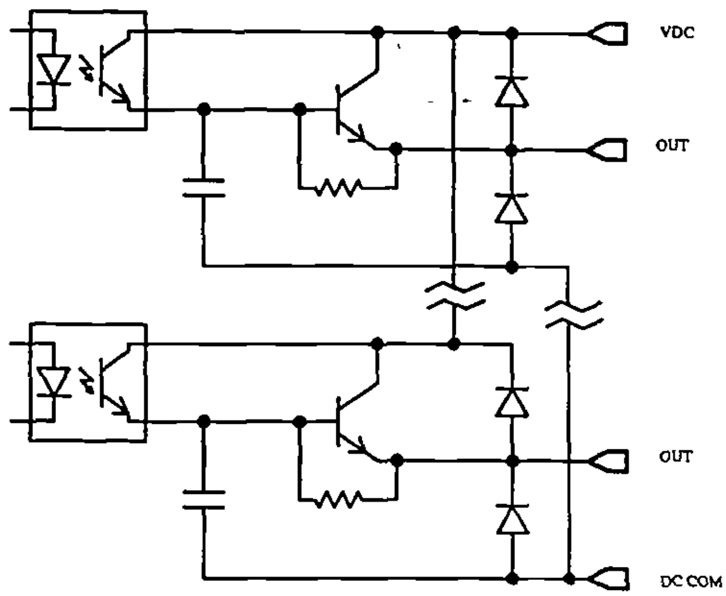


On/Off State Voltage Ranges – All Other Inputs



685 579

Output Circuit Diagram

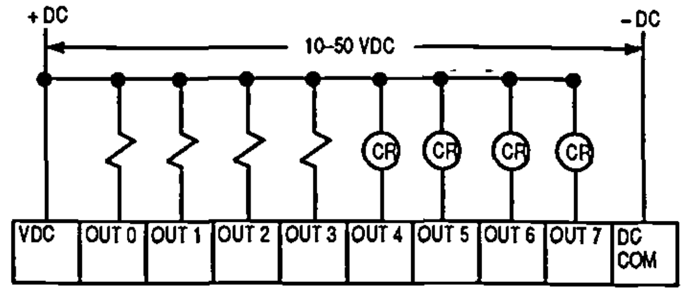


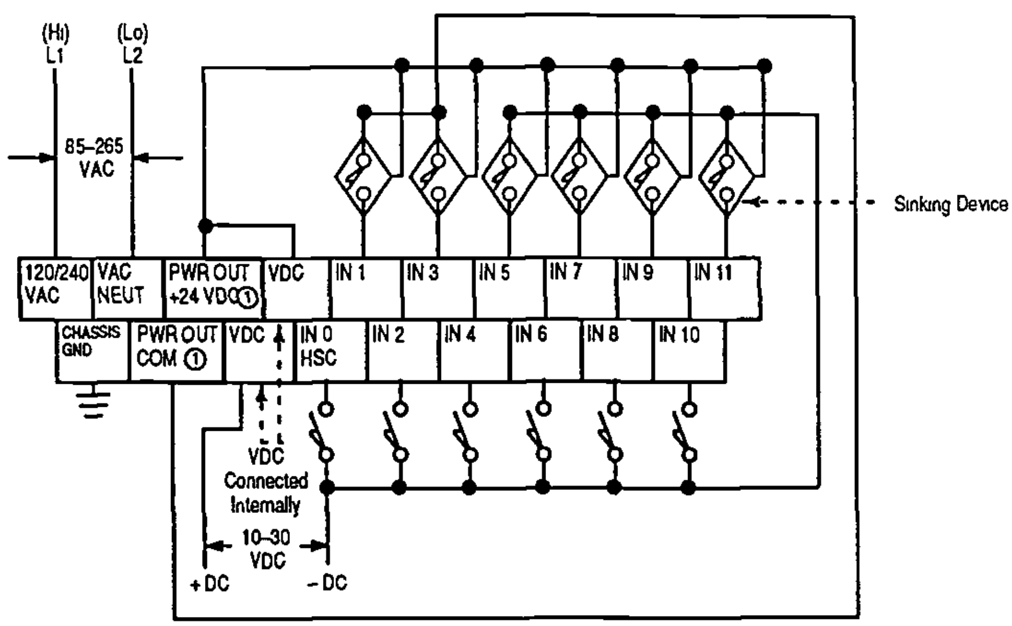
Operating Voltage Range

(Voltage is applied between +VDC and DC common.)

Catalog Number 1747–L20L (12) 24 VDC Sourcing Inputs, High–Speed Counter Input & (8) Transistor Sinking Outputs

Wiring Diagram

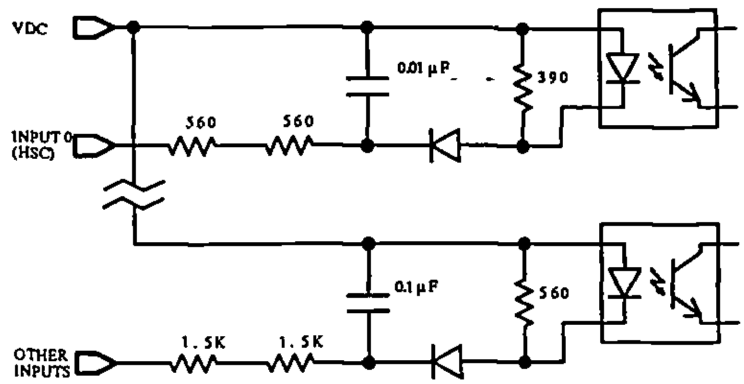




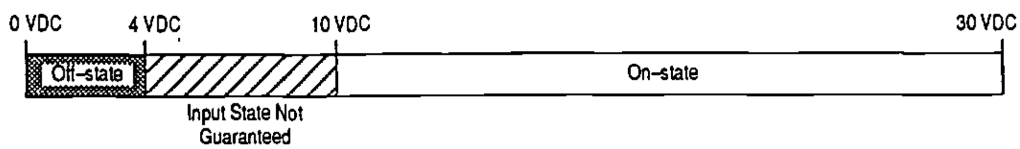
① *24 VDC, 200mA user power is available for sensors.*

685 581

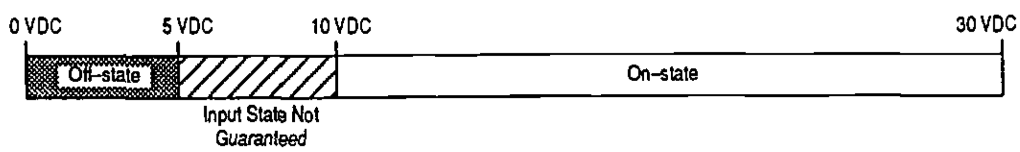
Input Circuit Diagram



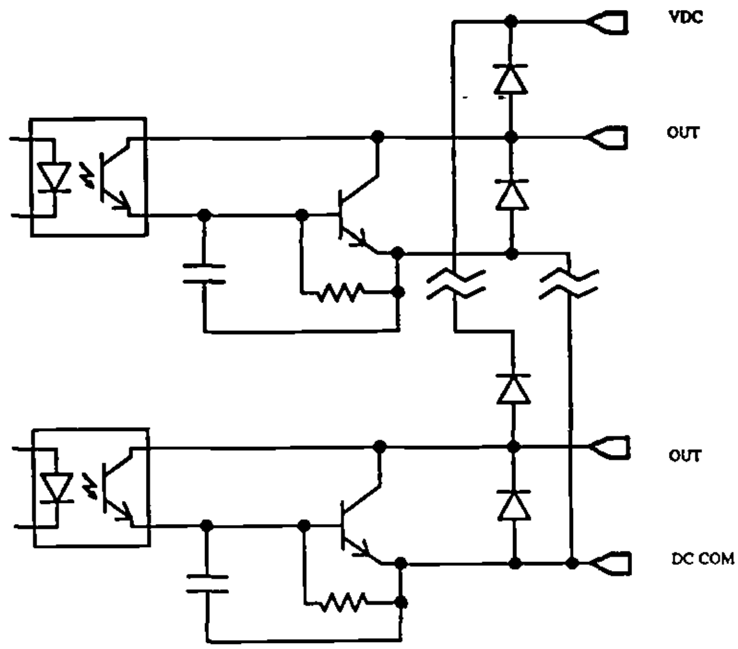
On/Off State Voltage Ranges – Input 0 (HSC)



On/Off State Voltage Ranges – All Other Inputs



Output Circuit Diagram



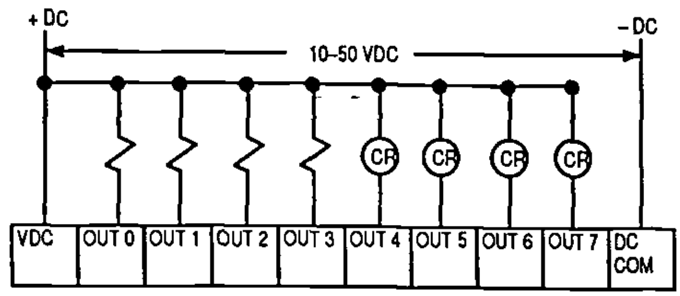
Operating Voltage Range

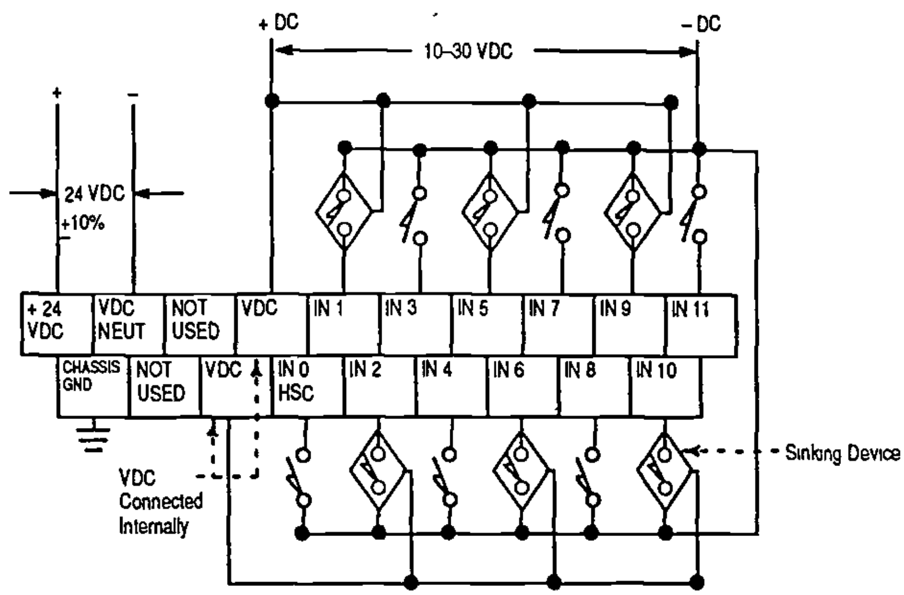
(Voltage is applied between +VDC and DC common.)

685 583

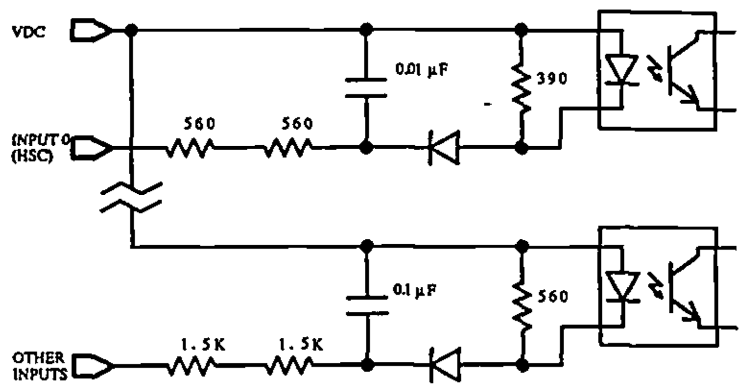
Catalog Number 1747–L20N (12) 24 VDC Sourcing Inputs, High–Speed Counter Input & (8) Transistor Sinking Outputs

Wiring Diagram

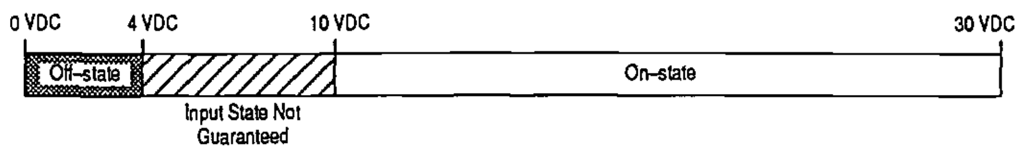




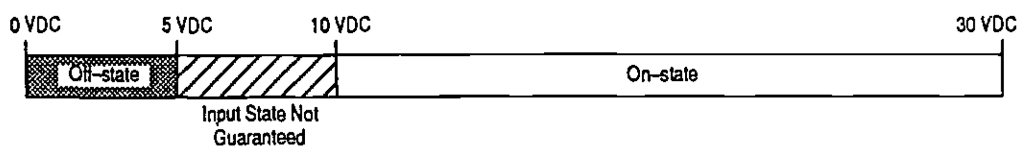
Input Circuit Diagram



On/Off State Voltage Ranges – Input 0 (HSC)

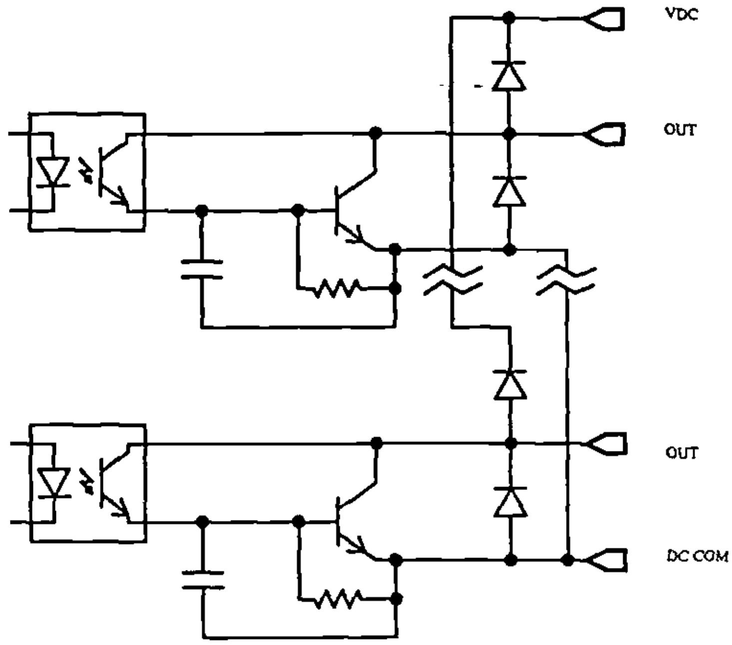


On/Off State Voltage Ranges – All Other Inputs



685 585

Output Circuit Diagram

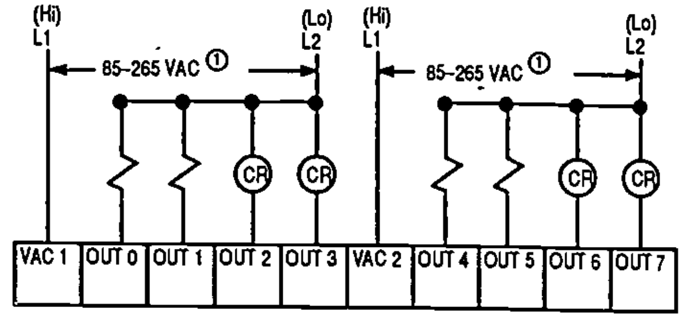


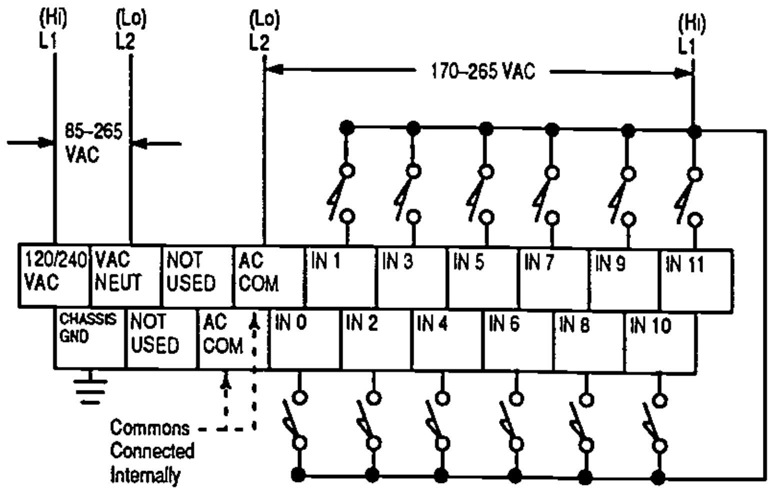
Operating Voltage Range

(Voltage is applied between +VDC and DC common)

Catalog Number 1747–L20P (12) 240 VAC Inputs & (8) Triac Outputs

Wiring Diagram

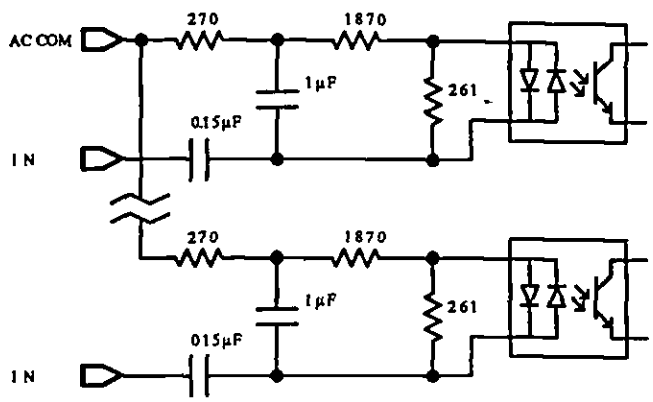




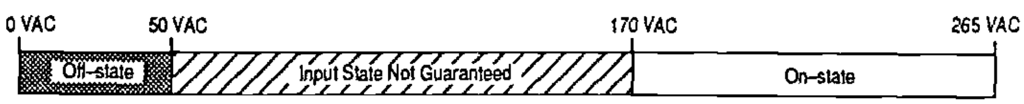
① *These outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

685 587

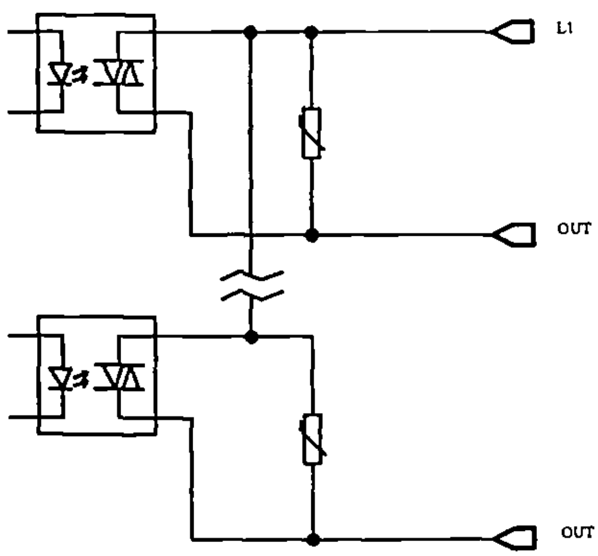
Input Circuit Diagram



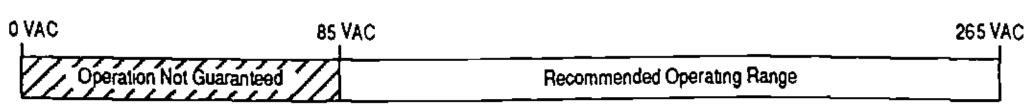
On/Off State Voltage Ranges



Output Circuit Diagram



Operating Voltage Range

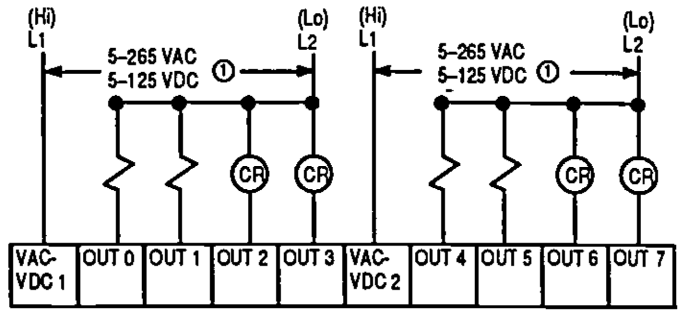


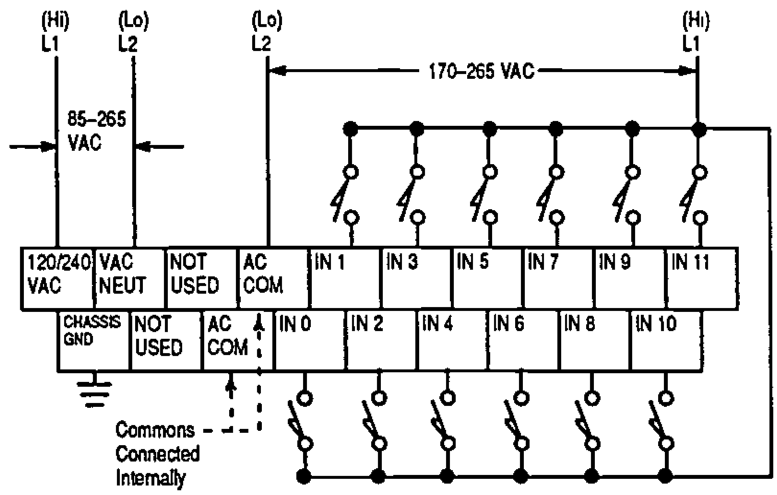
Important: If you measure the voltage at an output terminal that is not connected to a load or is connected to a high–impedanc load, you may measure as much as 100 VAC even though the output is off

685 588

Catalog Number 1747–L20R (12) 240 VAC Inputs & (8) Relay Outputs

Wiring Diagram

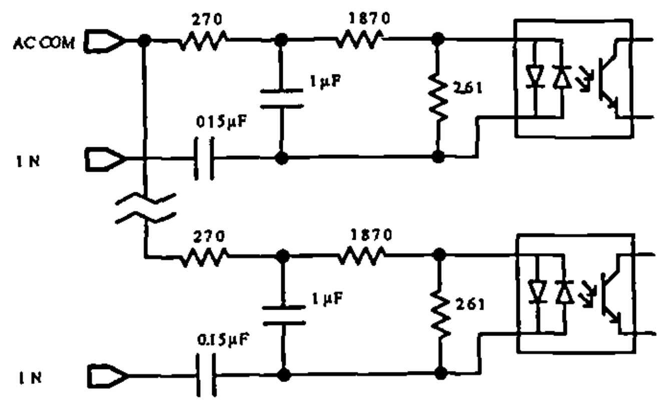




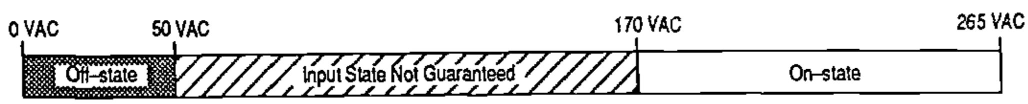
① *These outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

685 539

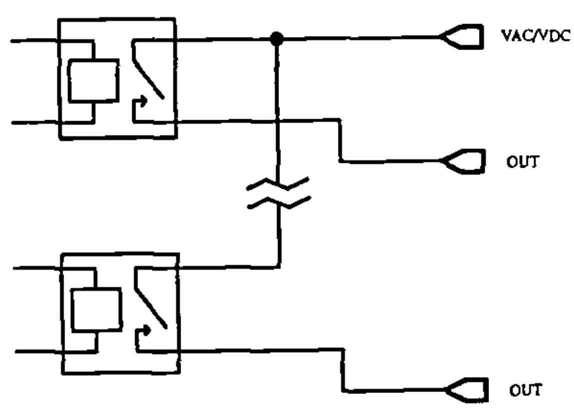
Input Circuit Diagram



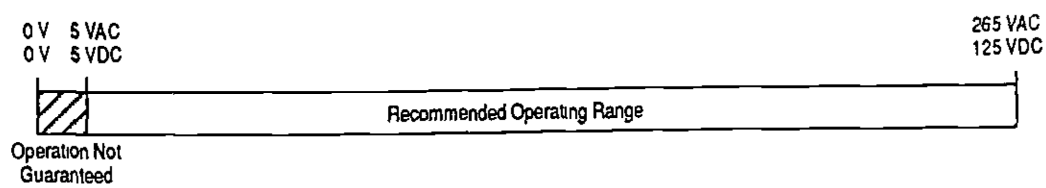
On/Off State Voltage Ranges



Output Circuit Diagram

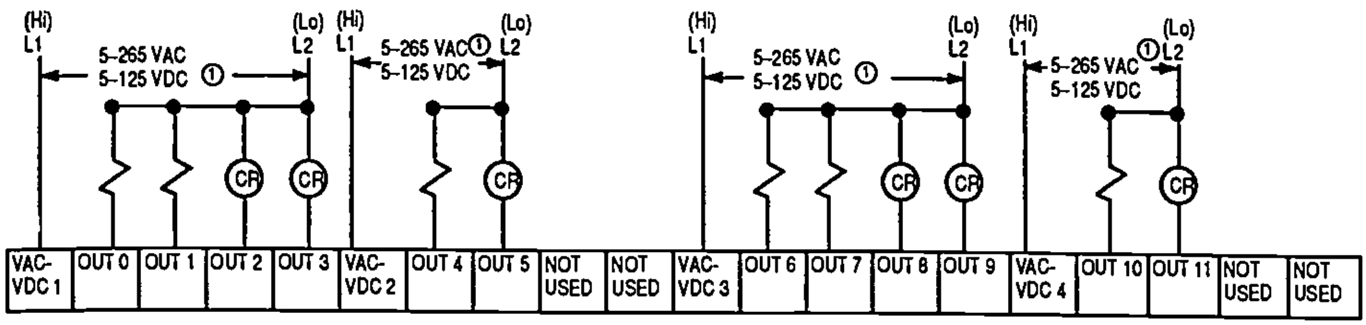


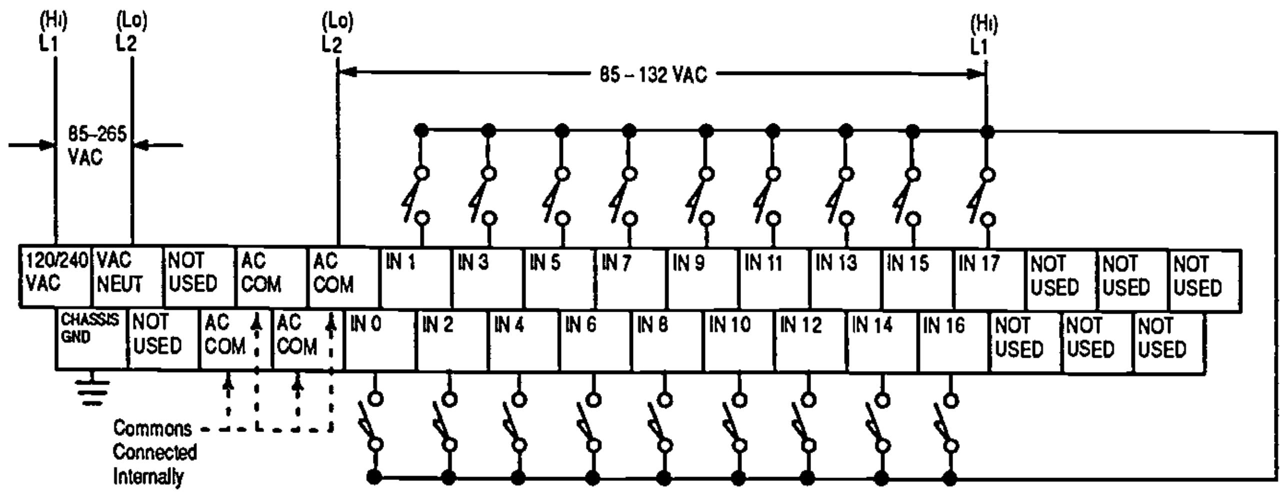
Operating Voltage Range



Catalog Number 1747–L30A (18) 120 VAC Inputs & (12) Relay Outputs

Wiring Diagram

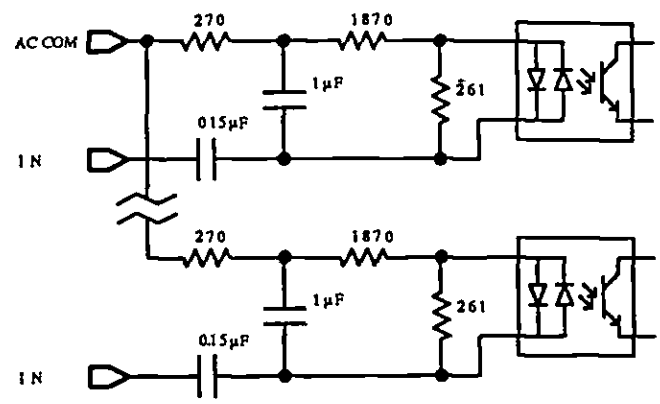




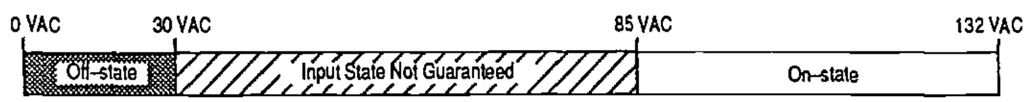
① *These outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

685 591

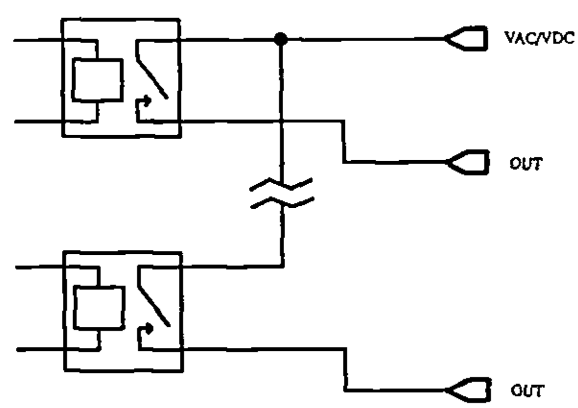
Input Circuit Diagram



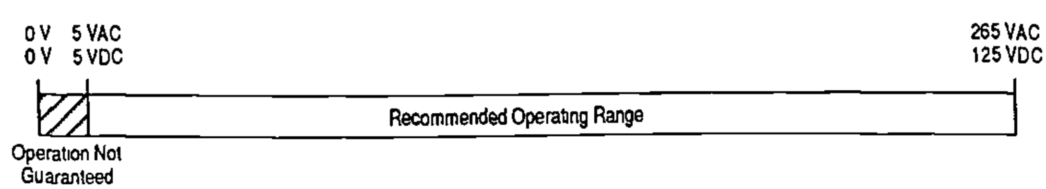
On/Off State Voltage Ranges



Output Circuit Diagram

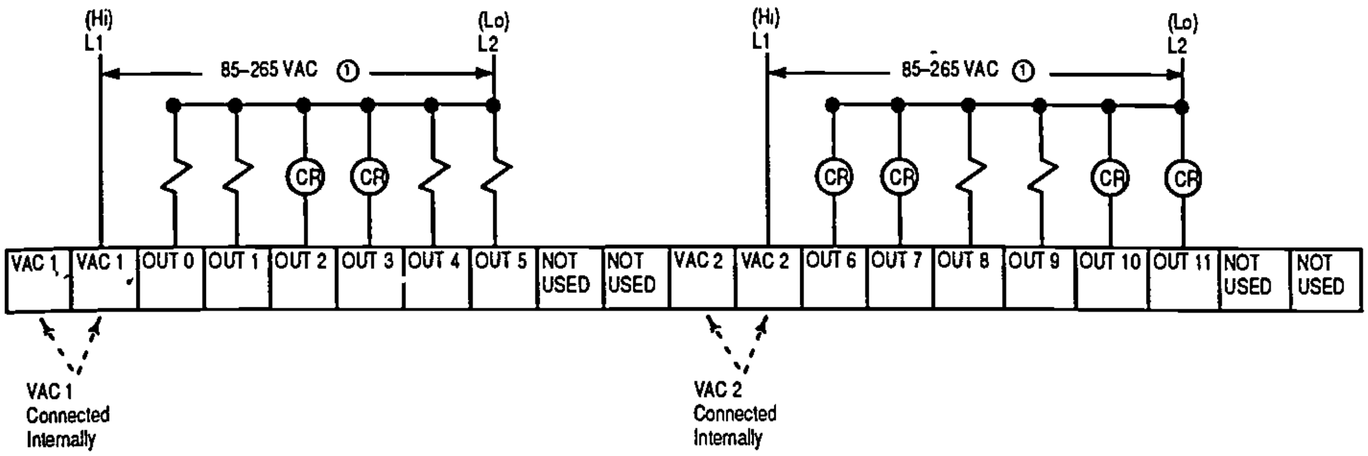


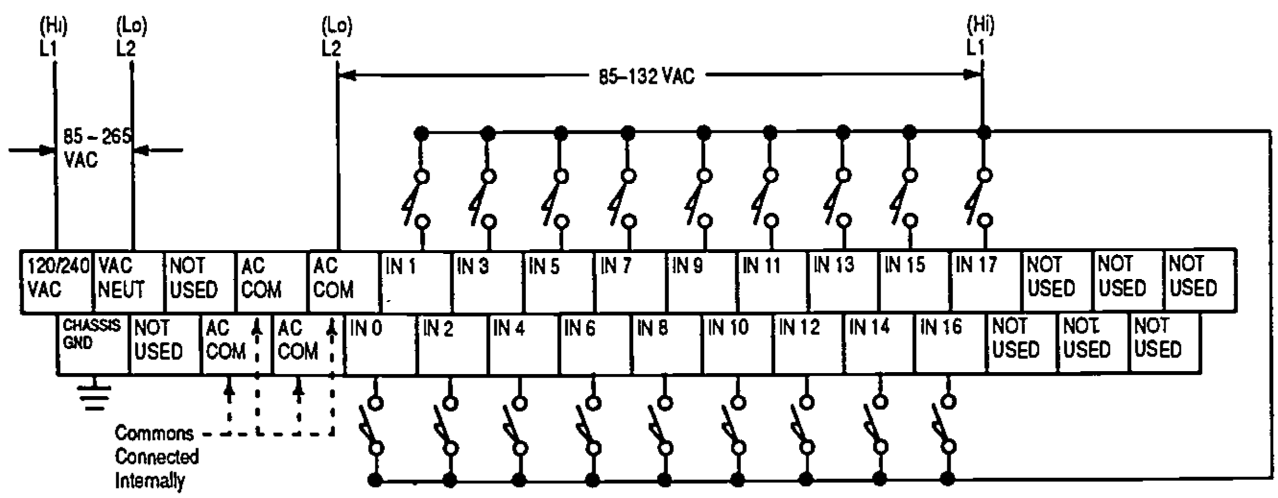
Operating Voltage Range



Catalog Number 1747–L30B (18) 120 Vac Inputs & (12) Triac Outputs

Wiring Diagram

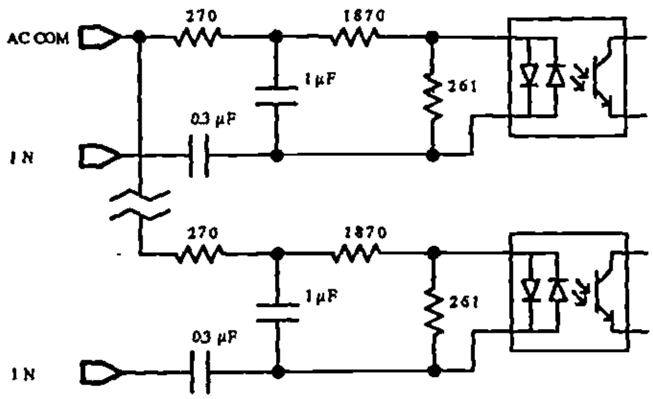




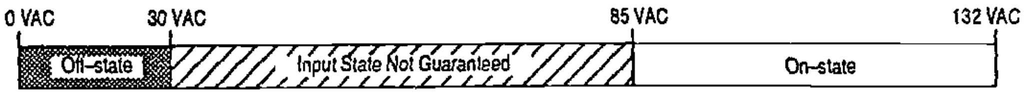
① *These outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

685 593

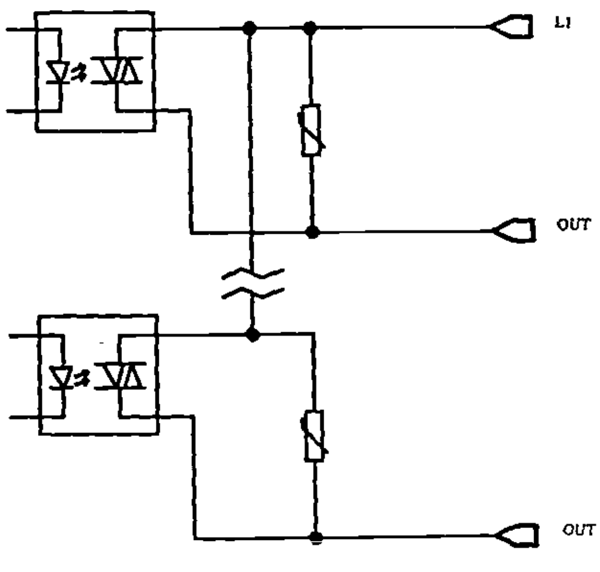
Input Circuit Diagram



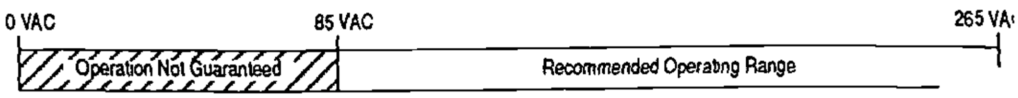
On/Off State Voltage Ranges



Output Circuit Diagram



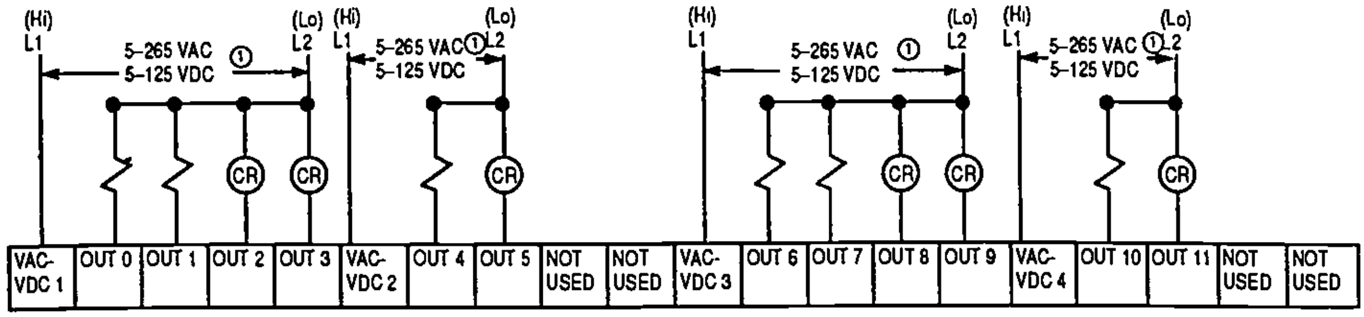
Operating Voltage Range

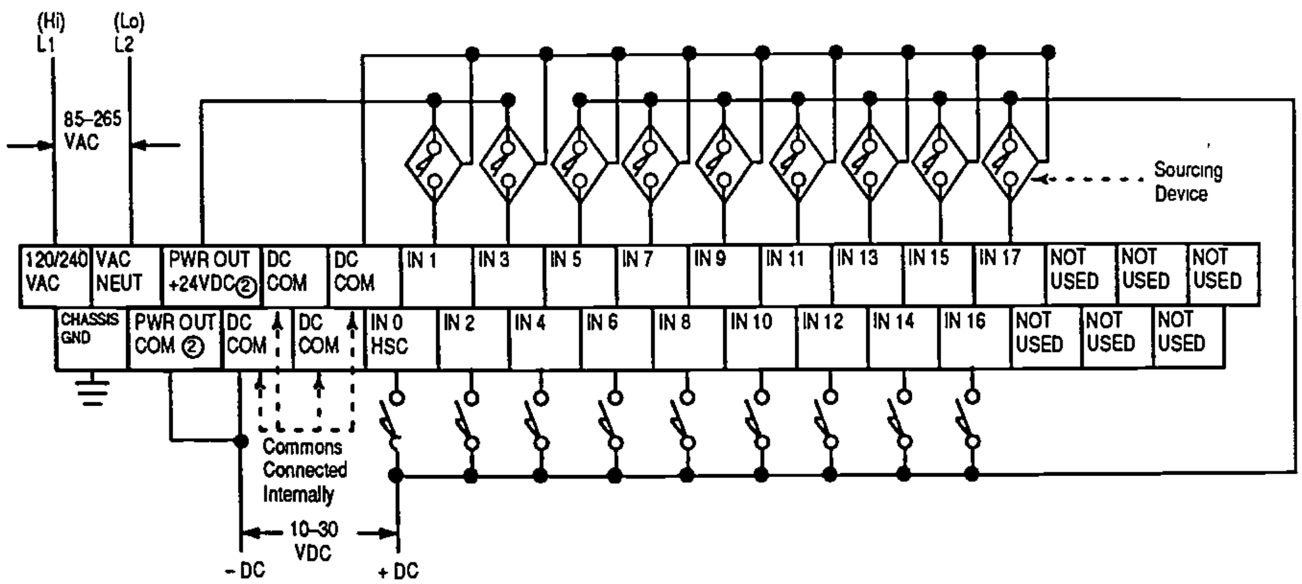


Important: If you measure the voltage at an output terminal that is not connected to a load or is connected to a high-im load, you may measure as much as 100 VAC even though the output is off

Catalog Number 1747–L30C (18) 24 VDC Sinking Inputs, High–Speed Counter Input & (12) Relay Outputs

Wiring Diagram



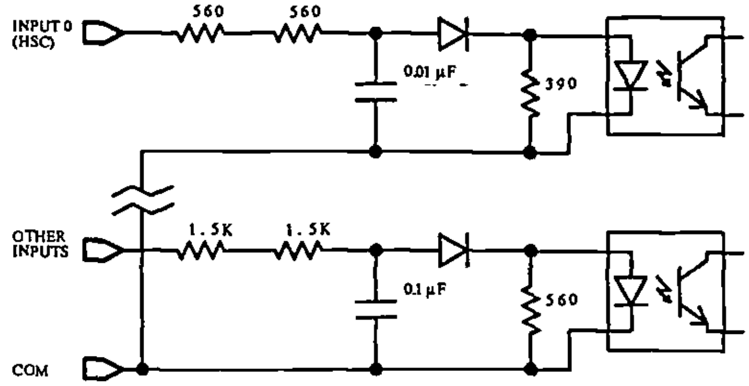


① *The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

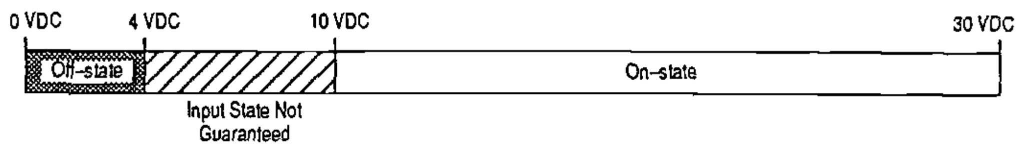
② *24 VDC, 200mA user power is available for sensors.*

685 595.

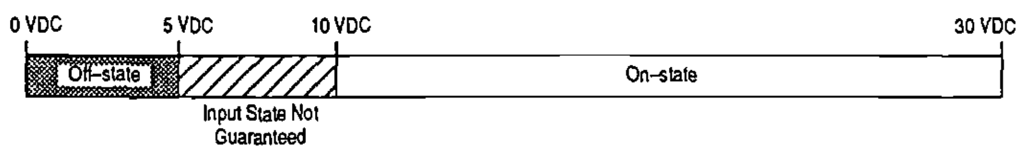
Input Circuit Diagram



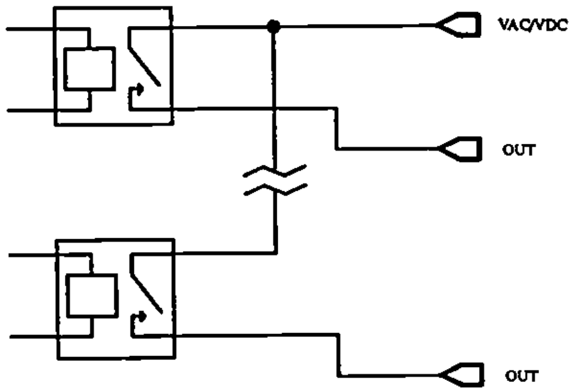
On/Off State Voltage Ranges – Input 0 (HSC)



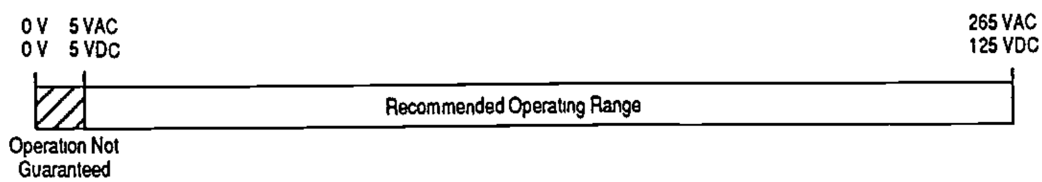
On/Off State Voltage Ranges – All Other Inputs



Output Circuit Diagram



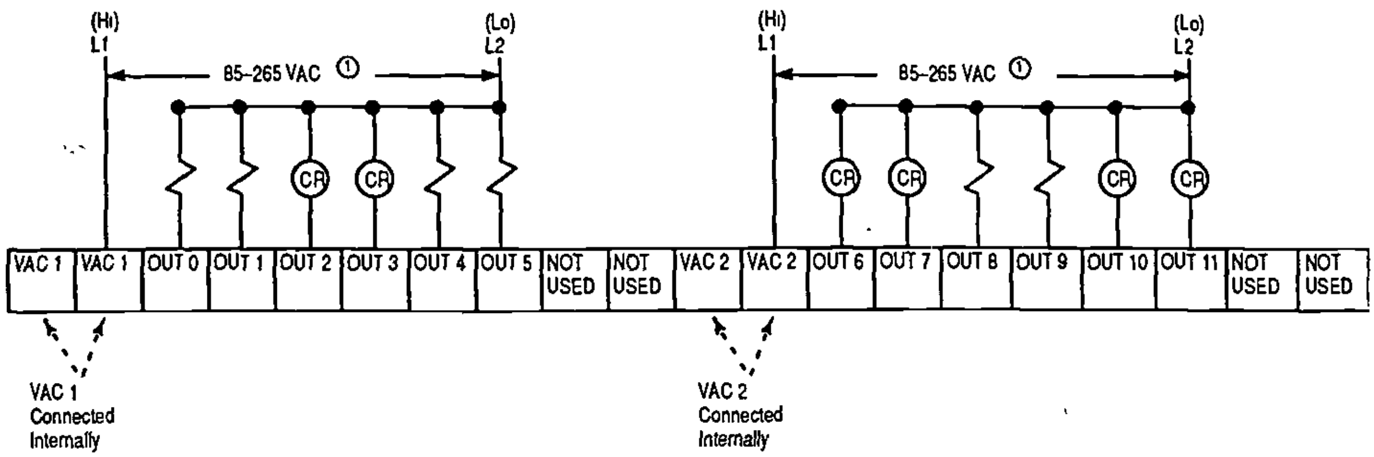
Operating Voltage Range

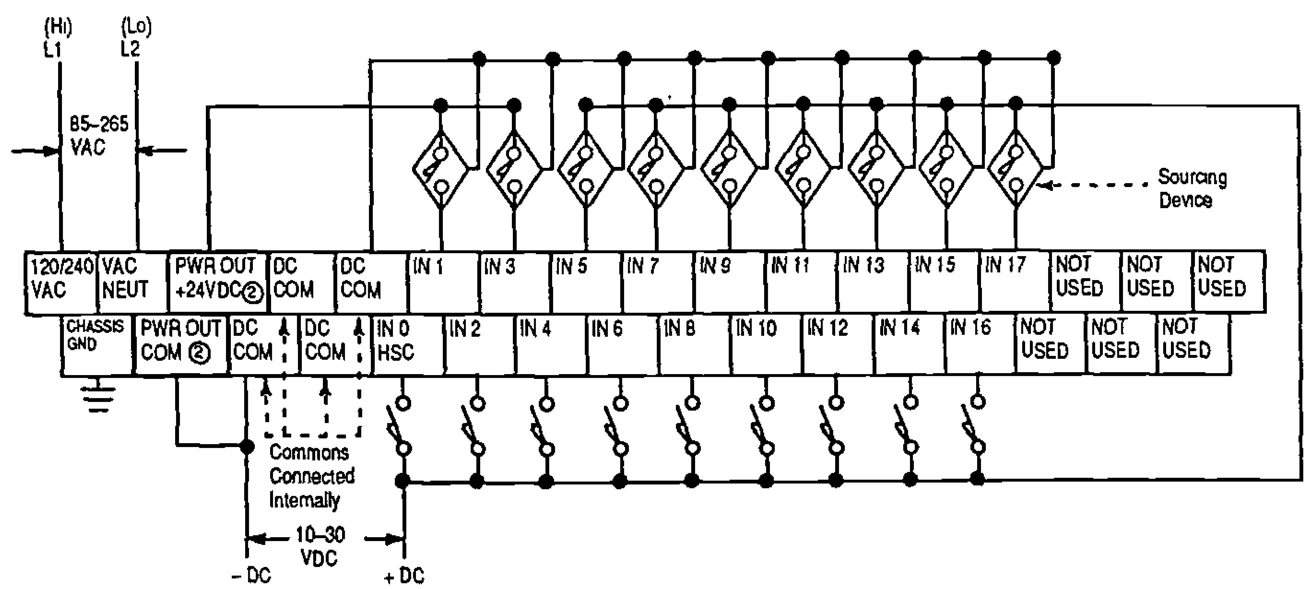


685 597

Catalog Number 1747–L30D (18) 24 VDC Sinking Inputs, High–Speed Counter Input & (12) Triac Outputs

Wiring Diagram

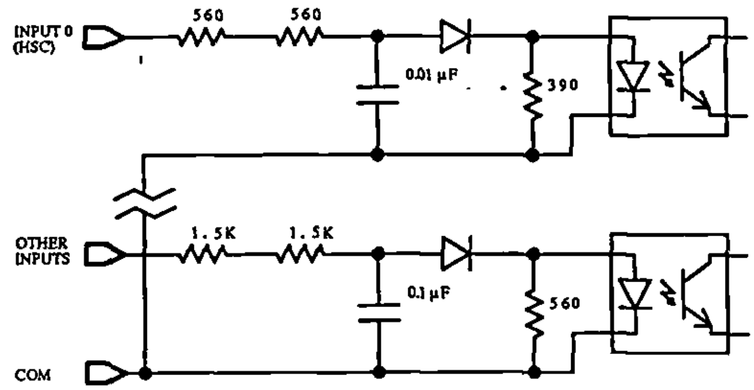




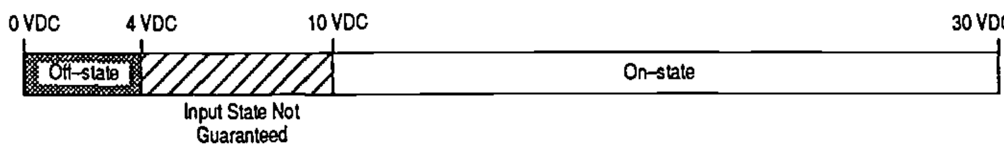
① *The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

② *24 VDC, 200mA user power is available for sensors*

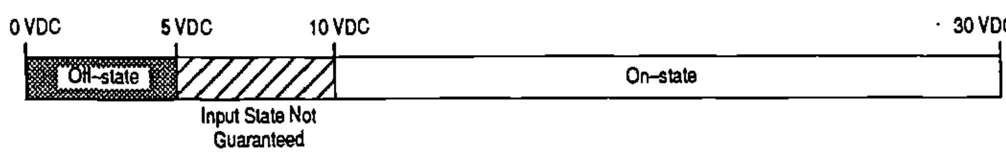
Input Circuit Diagram



On/Off State Voltage Ranges – Input 0 (HSC)

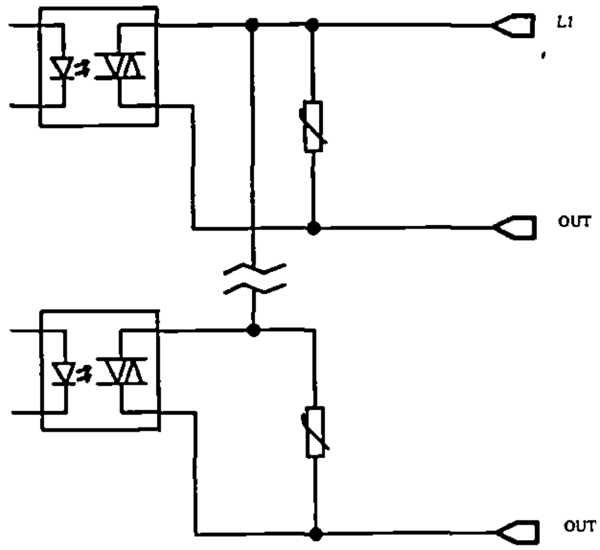


On/Off State Voltage Ranges – All Other Inputs

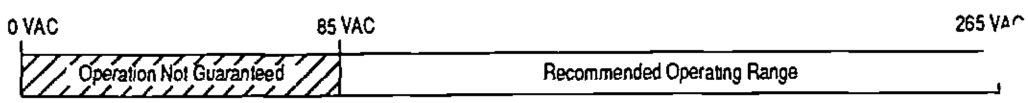


685 599

Output Circuit Diagram



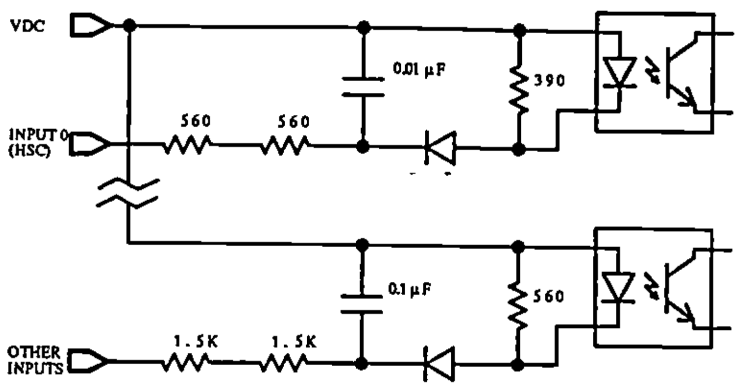
Operating Voltage Range



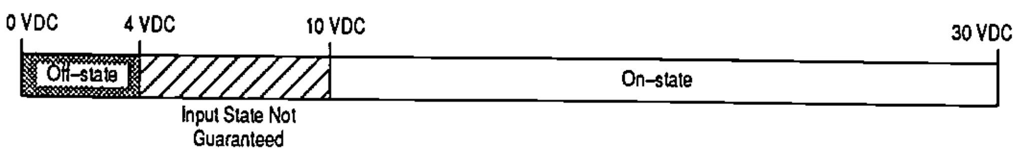
Important: If you measure the voltage at an output terminal that is not connected to a load or is connected to a high-impedance load, you may measure as much as 100 VAC even though the output is off

685 600

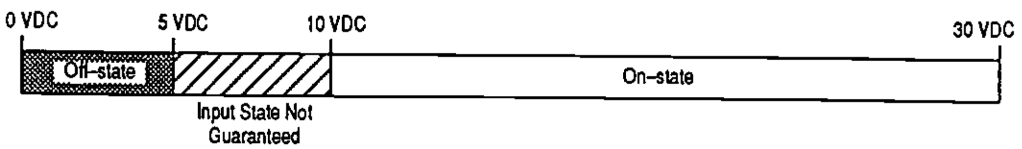
Input Circuit Diagram



On/Off State Voltage Ranges – Input 0 (HSC)



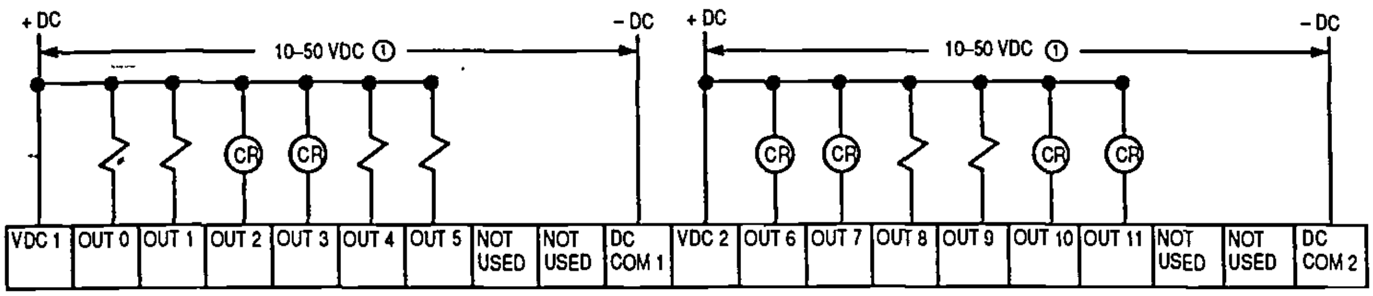
On/Off State Voltage Ranges – All Other Inputs

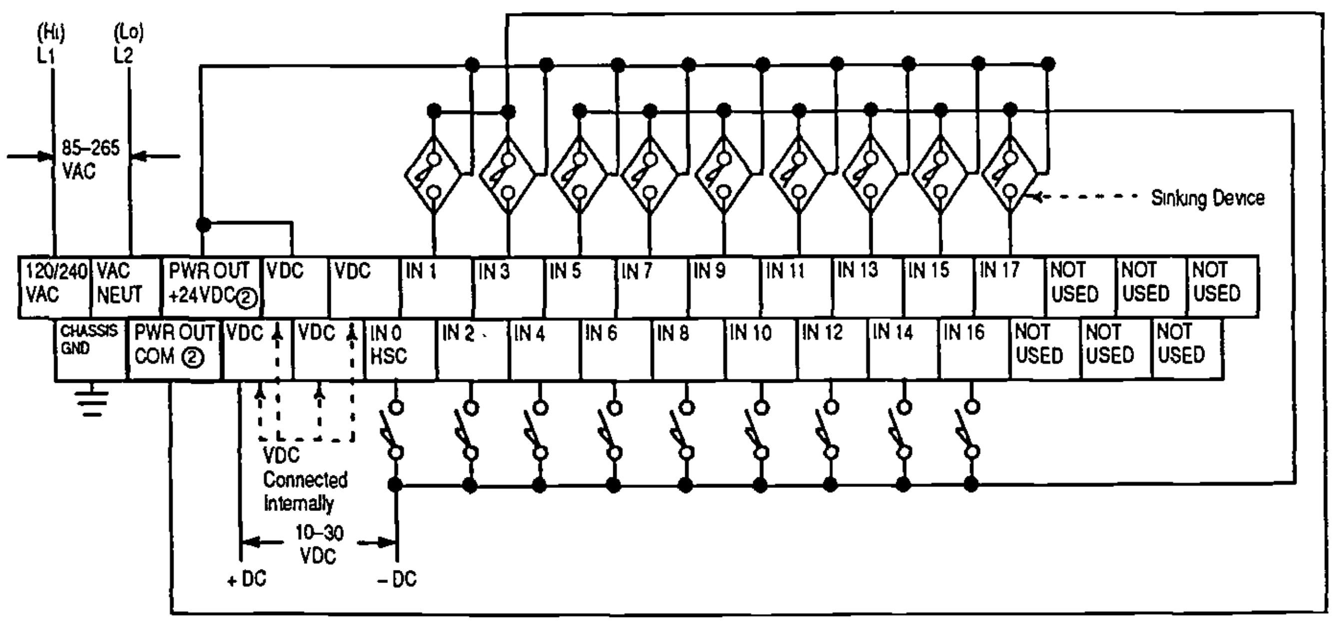


685 601

Catalog Number 1747–L30L (18) 24 VDC Sourcing Inputs, High–Speed Counter Input & (12) Transistor Sinking Outputs

Wiring Diagram

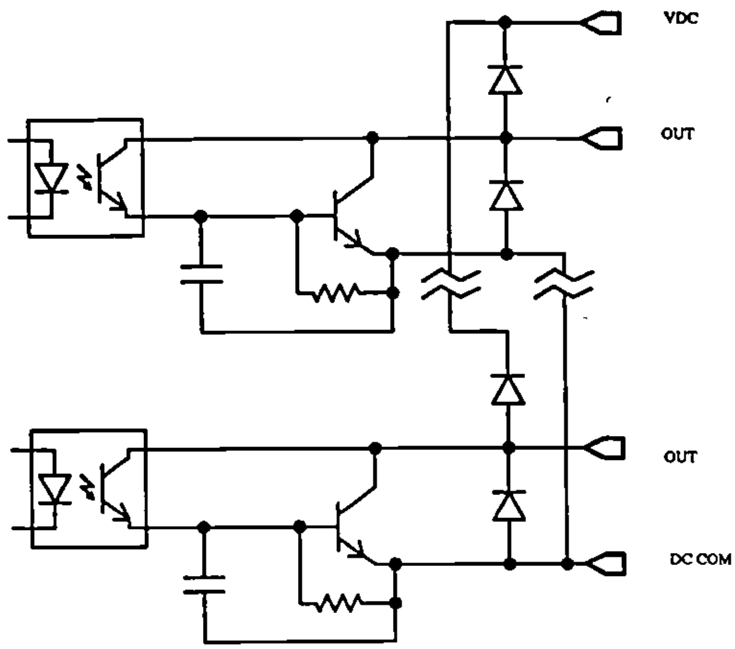




① The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.

② 24 VDC, 200mA user power is available for sensors.

Output Circuit Diagram



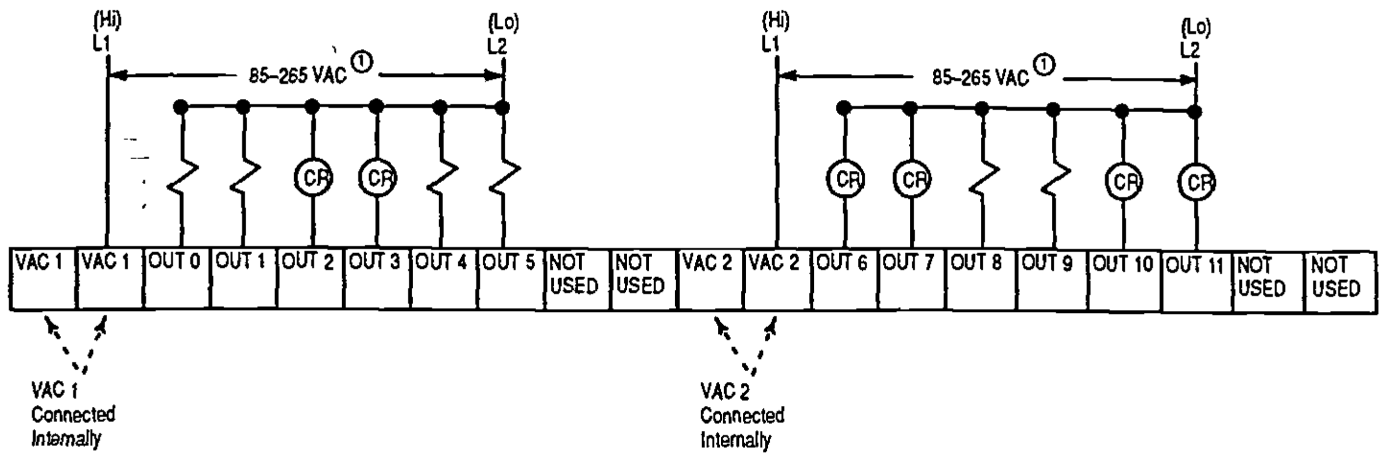
Operating Voltage Range

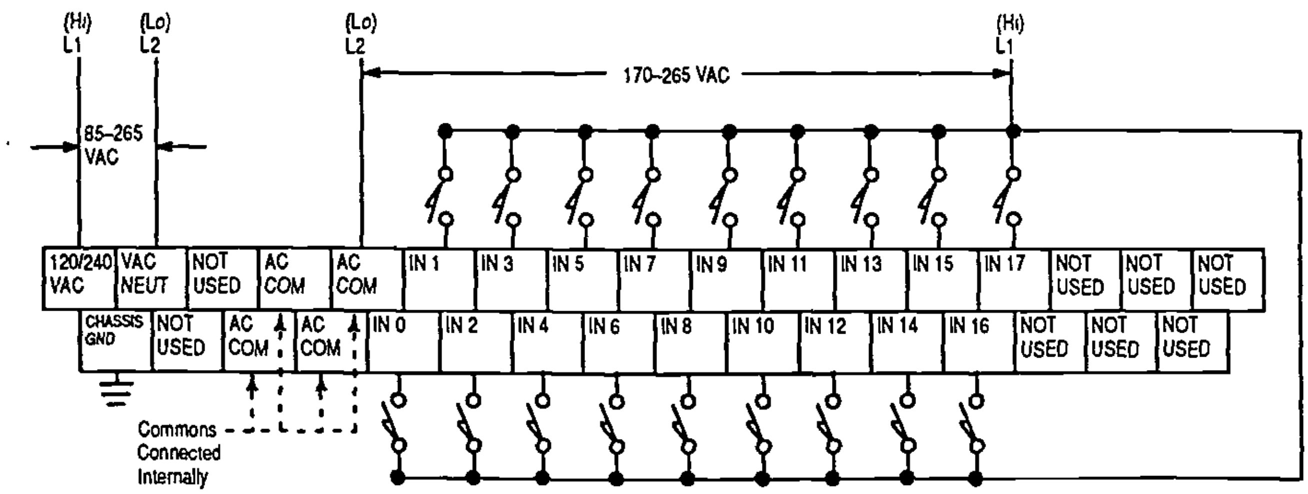
(Voltage is applied between +VDC and DC common)

685 603

Catalog Number 1747–L30P (18) 240 VAC Inputs & (12) Triac Outputs

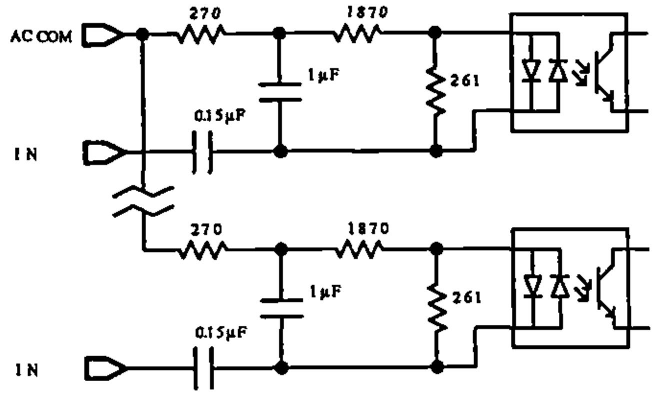
Wiring Diagram



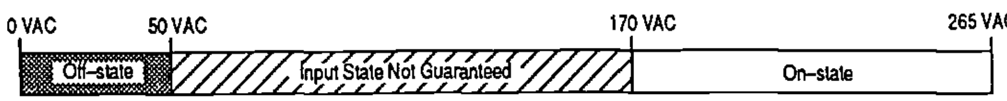


① *The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

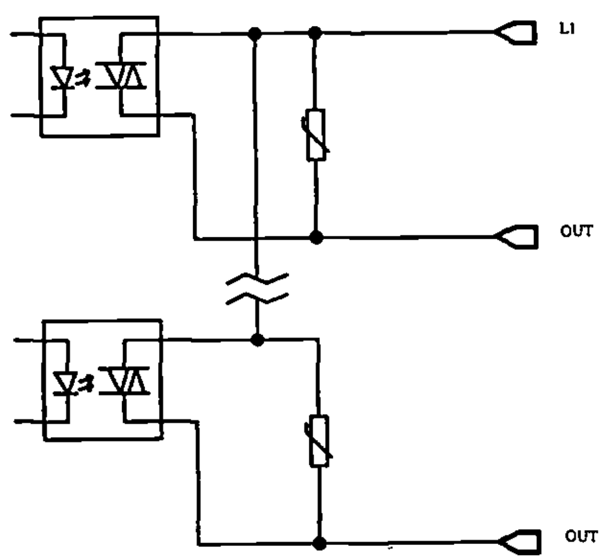
Input Circuit Diagram



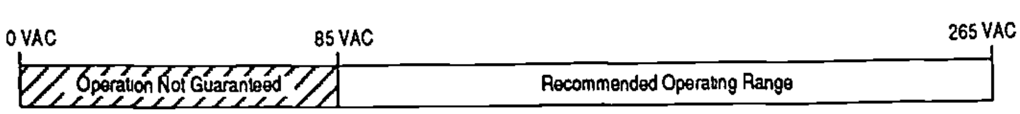
On/Off State Voltage Ranges



Output Circuit Diagram



Operating Voltage Range

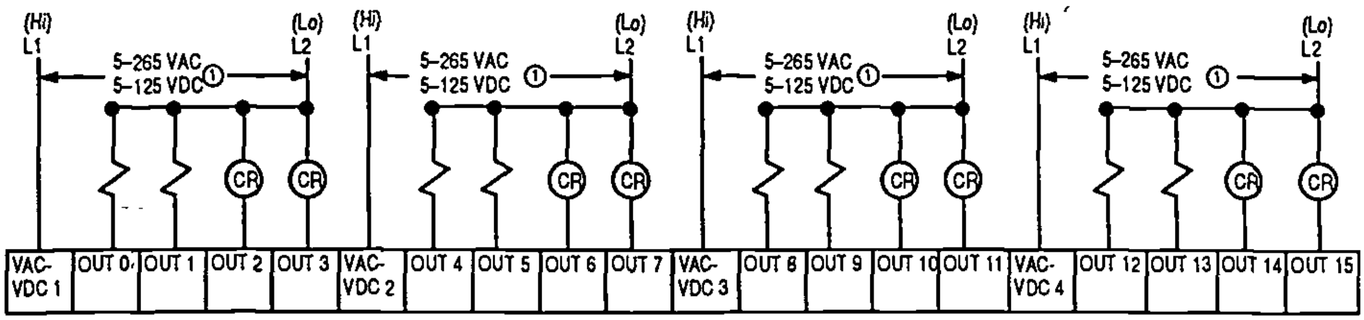


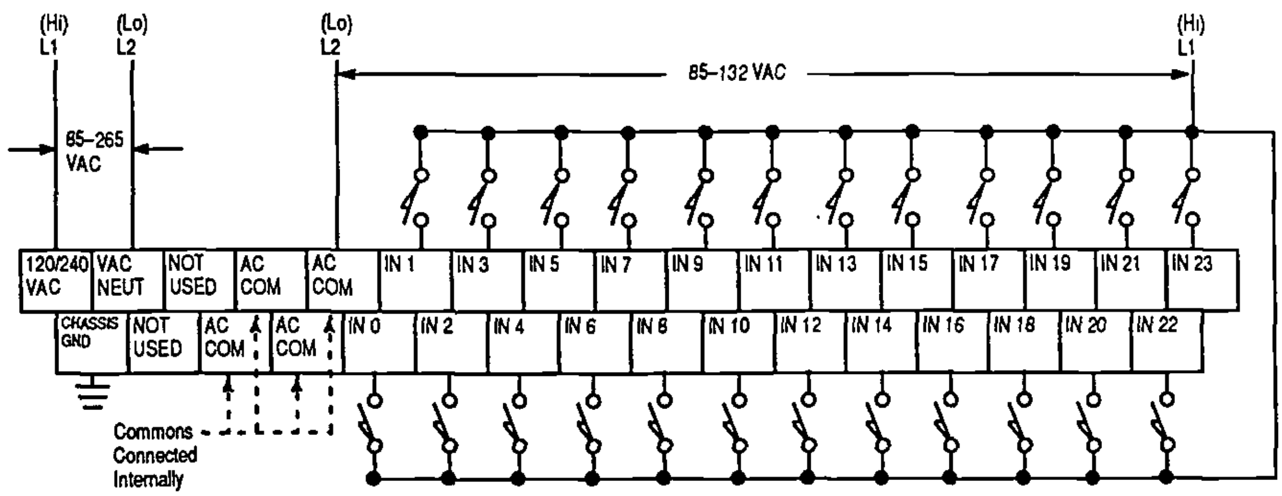
Important: If you measure the voltage at an output terminal that is not connected to a load or is connected to a high–impedance load, you may measure as much as 100 VAC even though the output is off

685 605

Catalog Number 1747–L40A (24) 120 VAC Inputs & (16) Relay Outputs

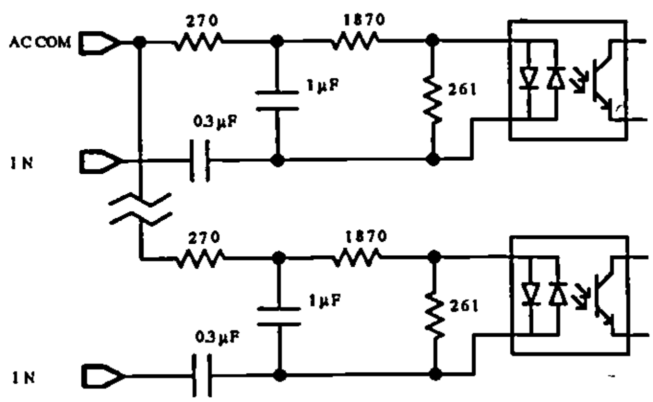
Wiring Diagram



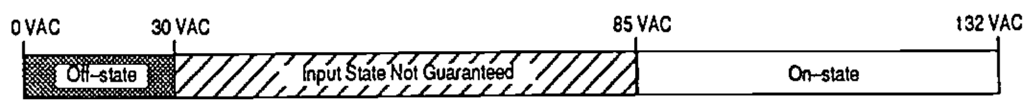


① The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.

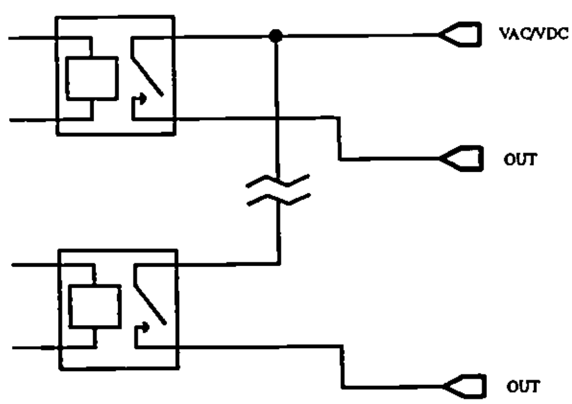
Input Circuit Diagram



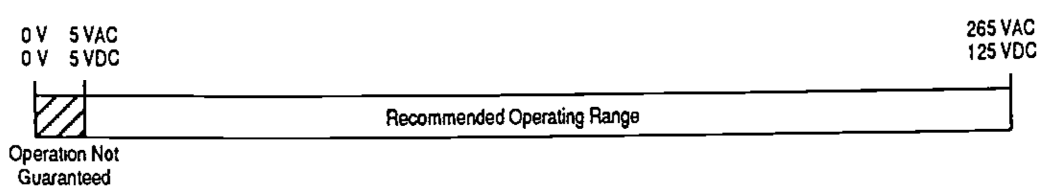
On/Off State Voltage Ranges



Output Circuit Diagram

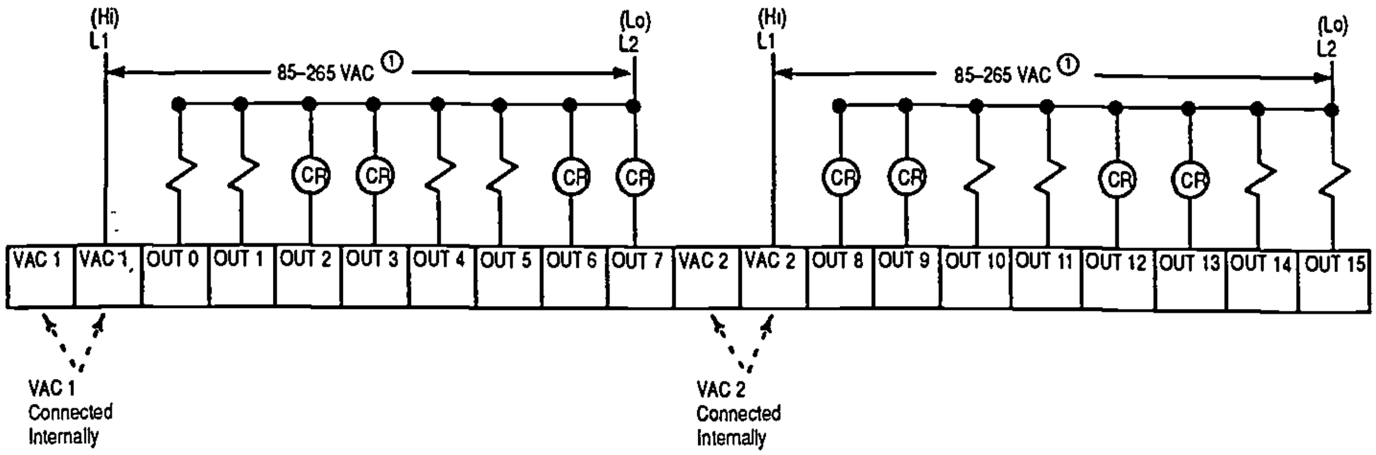


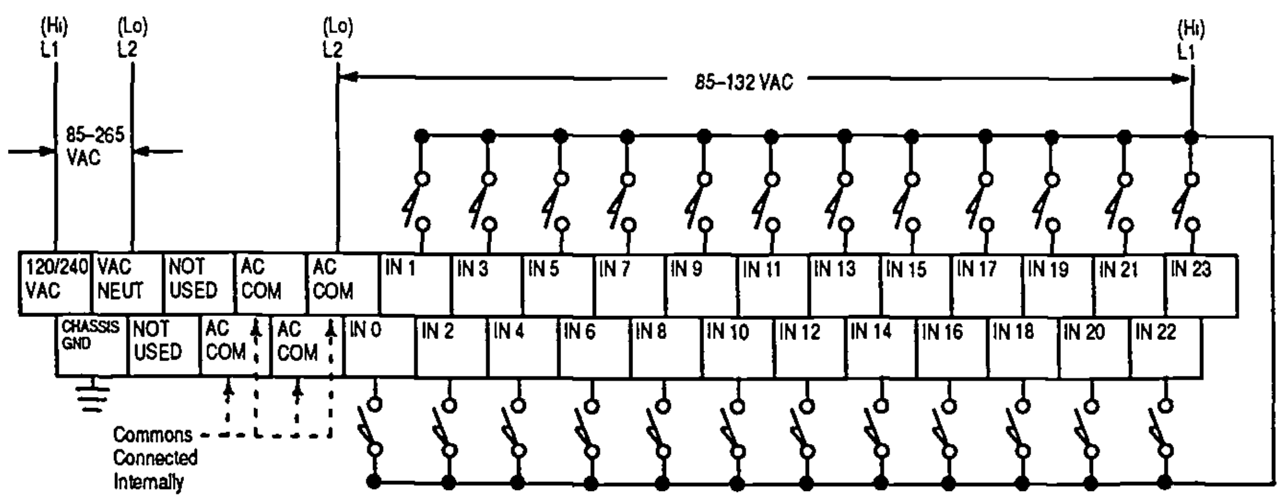
Operating Voltage Range



Catalog Number 1747–L40B (24) 120 VAC Inputs & (16) Triac Outputs

Wiring Diagram

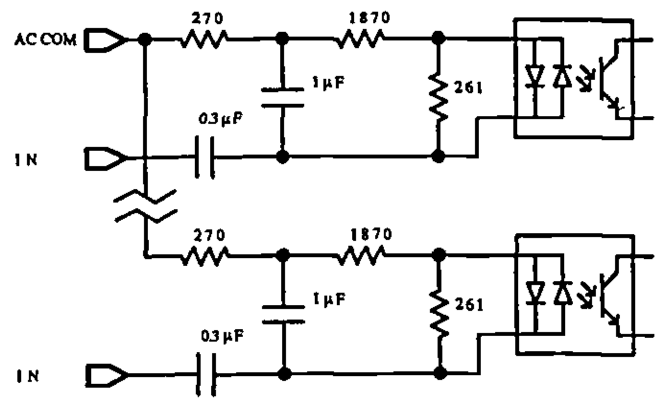




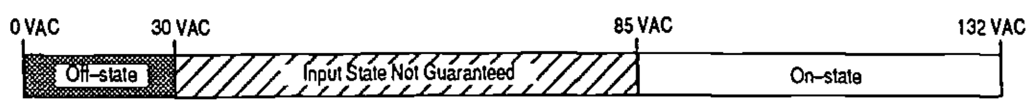
① *The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

685 608

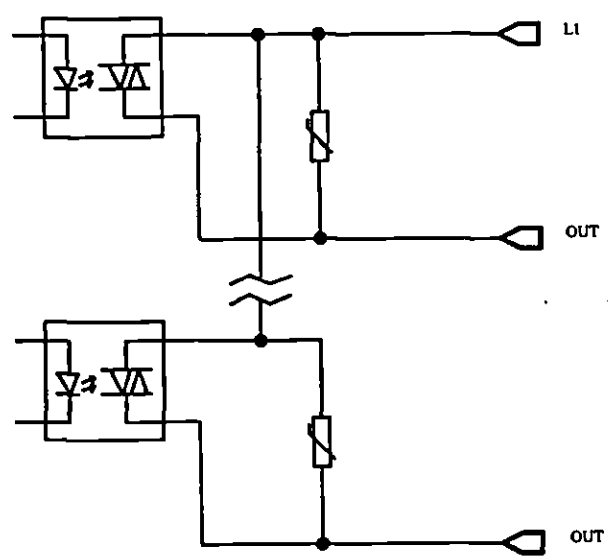
Input Circuit Diagram



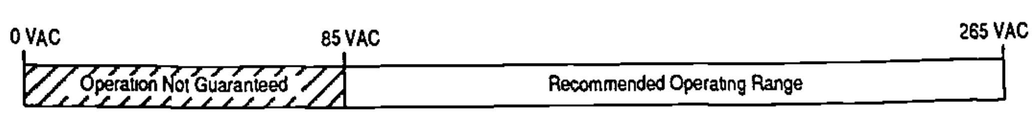
On/Off State Voltage Ranges



Output Circuit Diagram



Operating Voltage Range

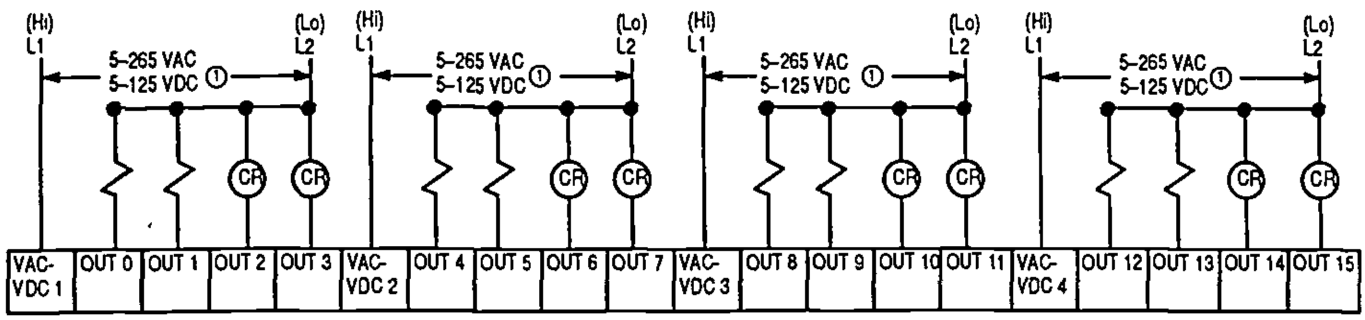


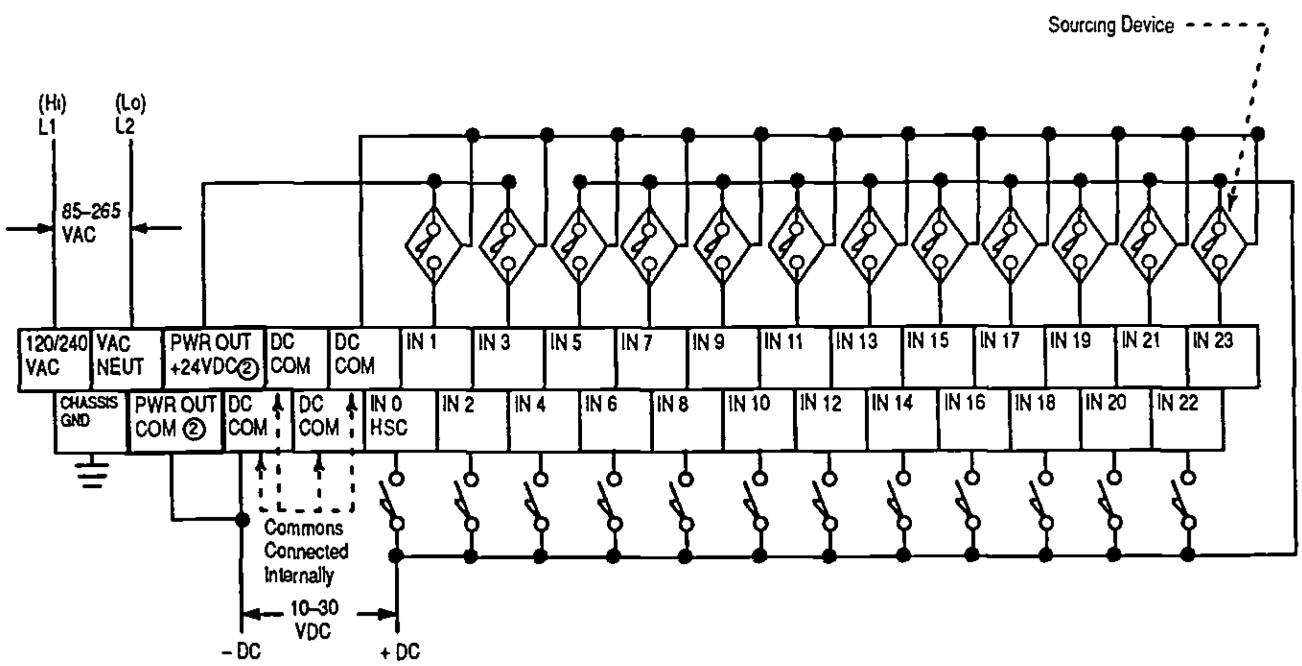
Important: If you measure the voltage at an output terminal that is not connected to a load or is connected to a high–impedance load, you may measure as much as 100 VAC even though the output is off

685 609

Catalog Number 1747–L40C (24) 24 VDC Sinking Inputs, High–Speed Counter Input & (16) Relay Outputs

Wiring Diagram

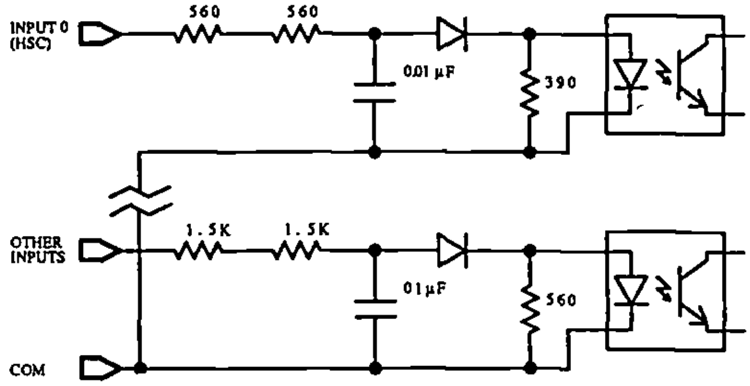




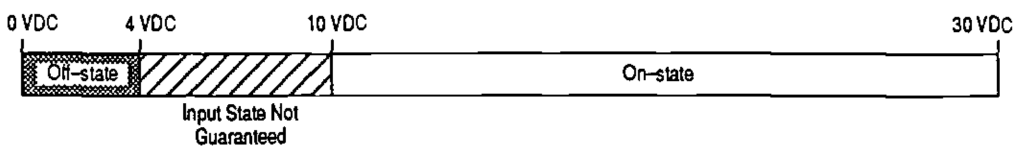
① *The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires*

② *24 VDC, 200mA user power is available for sensors*

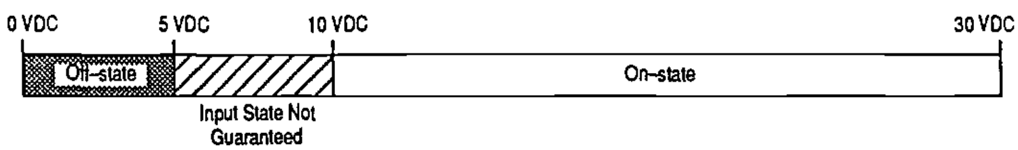
Input Circuit Diagram



On/Off State Voltage Ranges – Input 0 (HSC)

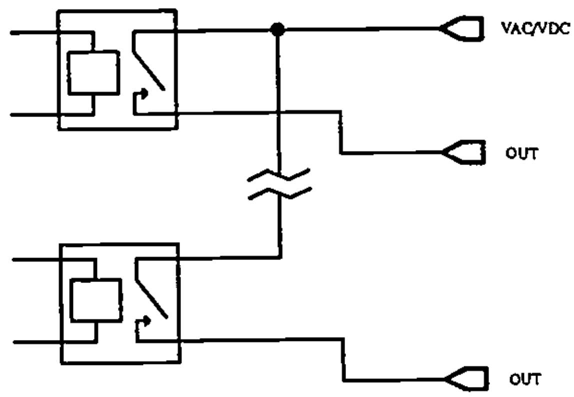


On/Off State Voltage Ranges – All Other Inputs

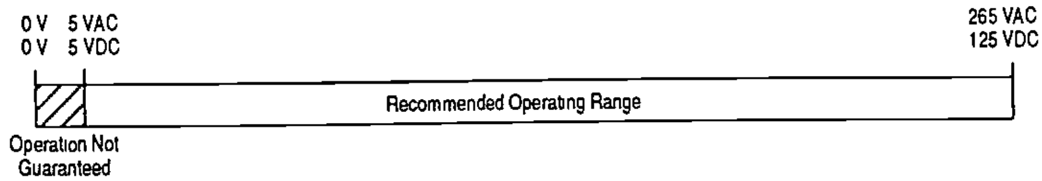


685 611

Output Circuit Diagram

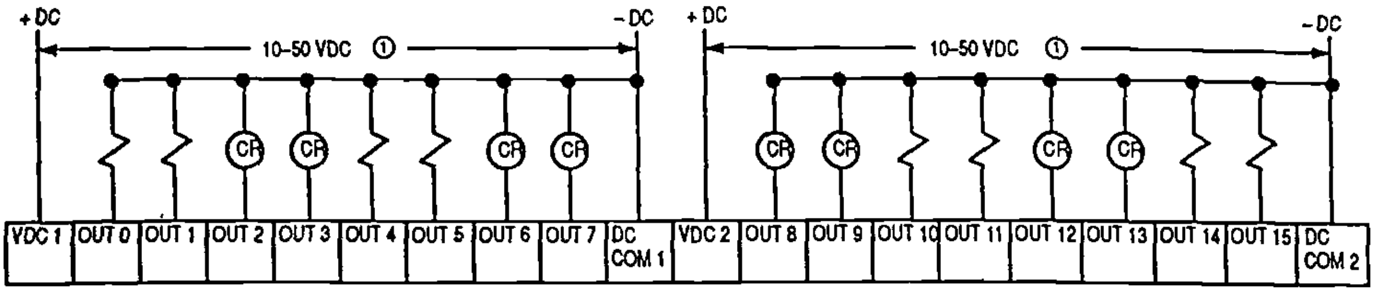


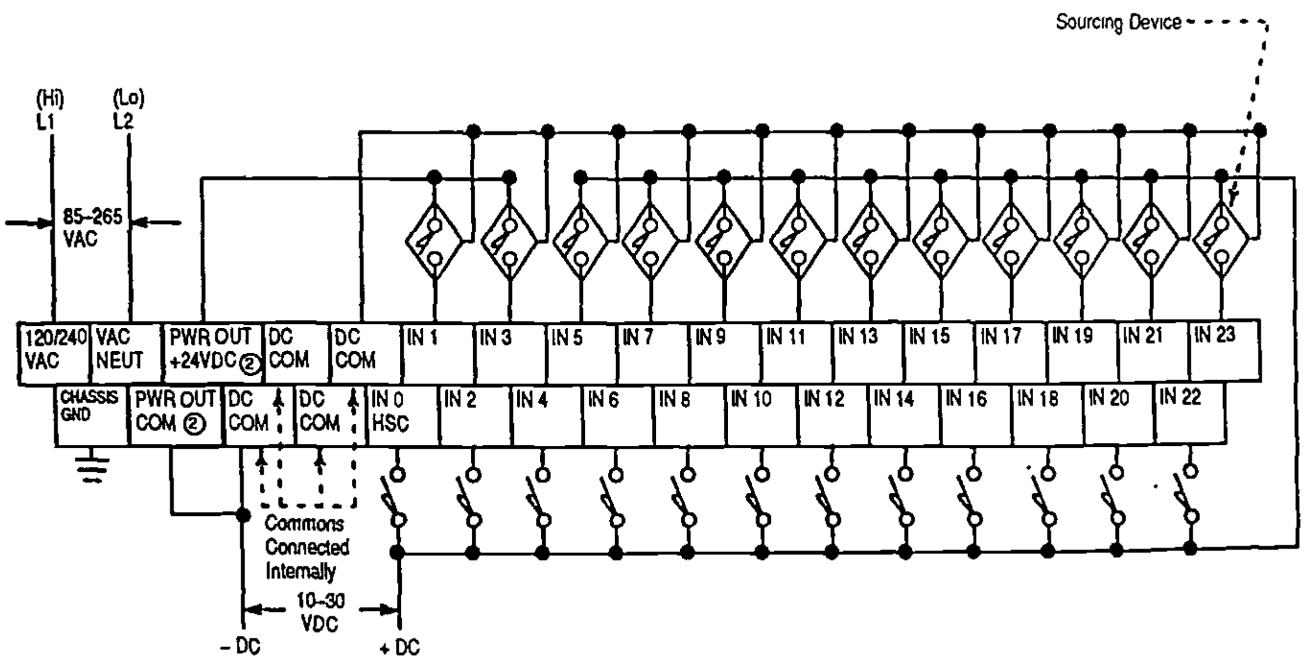
Operating Voltage Range



Catalog Number 1747-L40E (24) 24 VDC Sinking Inputs, High-Speed Counter Input & (16) Transistor Sourcing Outputs

Wiring Diagram





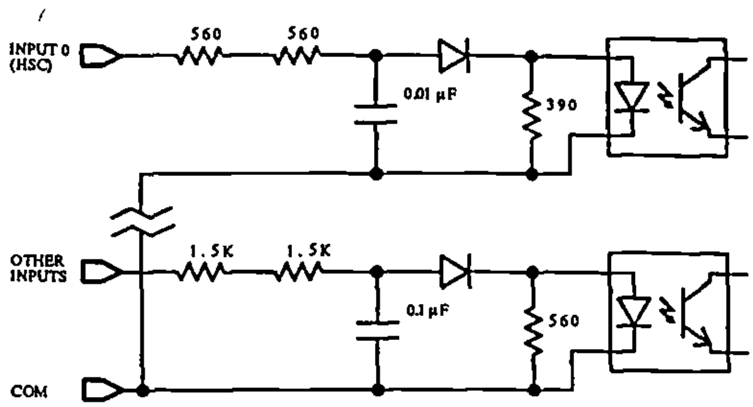
① *The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

② *24 VDC, 200mA user power is available for sensors*

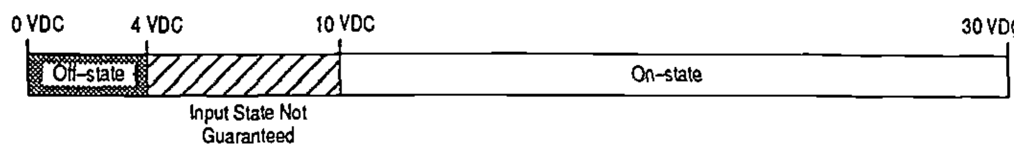
685 613

Appendix E
Wiring and Circuit Diagrams and Voltage Ranges for Your Fixed Controller

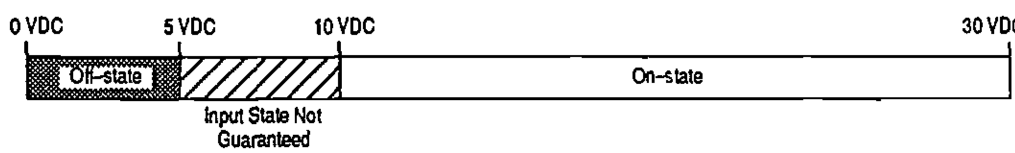
Input Circuit Diagram



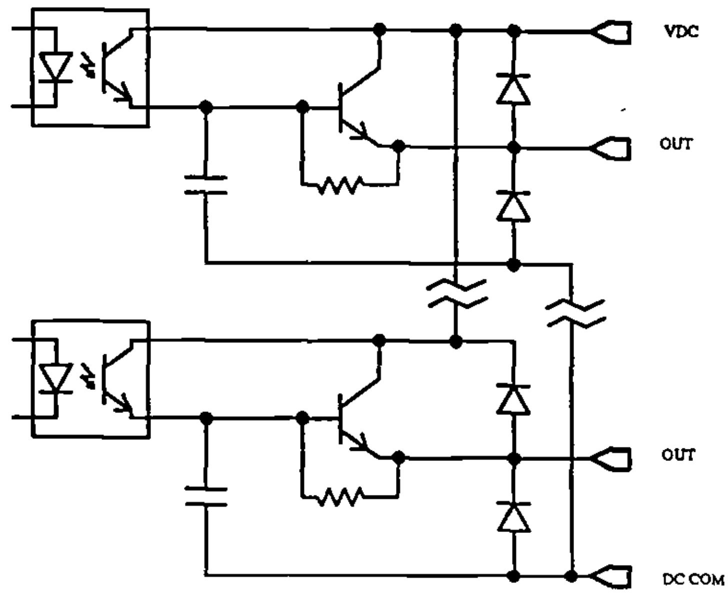
On/Off State Voltage Ranges – Input 0 (HSC)



On/Off State Voltage Ranges – All Other Inputs



Output Circuit Diagram



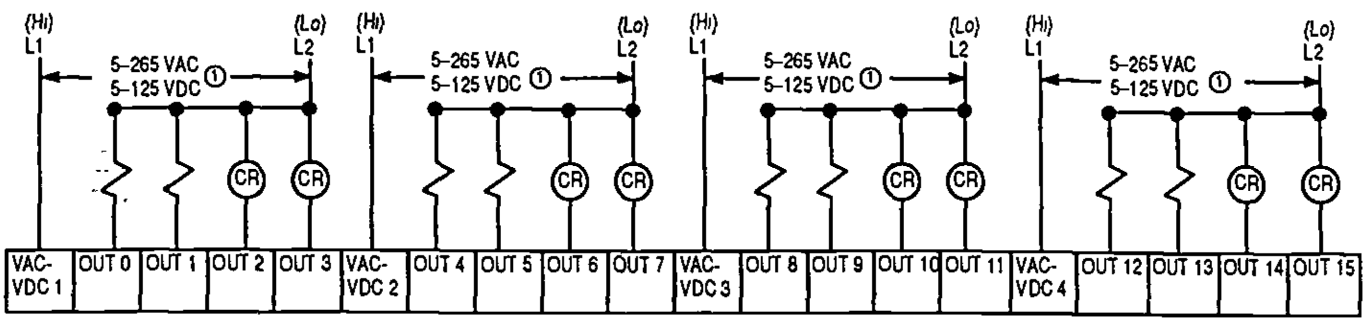
Operating Voltage Range

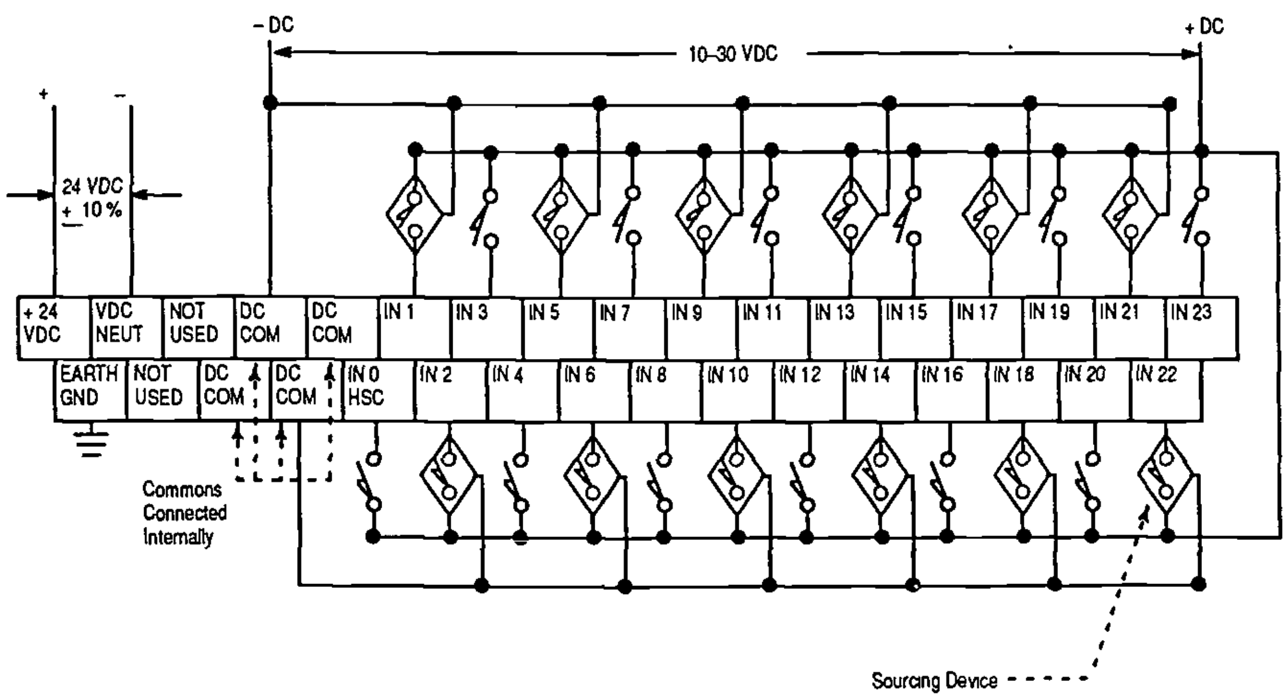
(Voltage is applied between +VDC and DC common)

683 615

Catalog Number 1747–L40F (24) 24 VDC Sinking Inputs, High–Speed Counter Input & (16) Relay Outputs

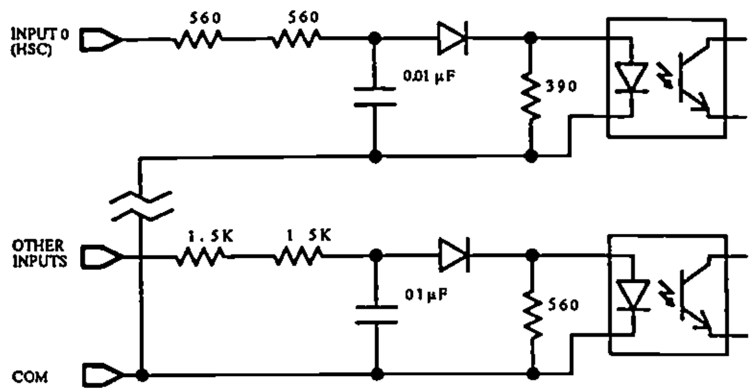
Wiring Diagram



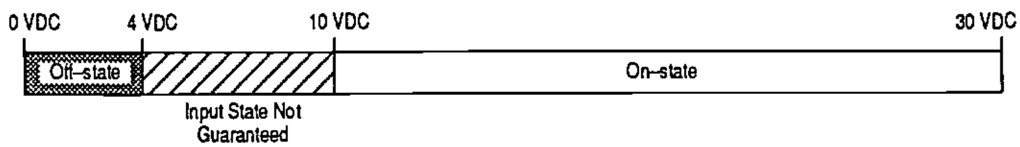


① *The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

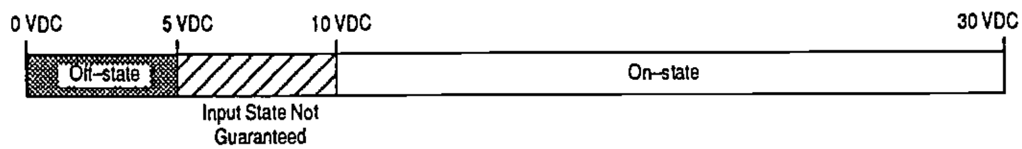
Input Circuit Diagram



On/Off State Voltage Ranges – Input 0 (HSC)

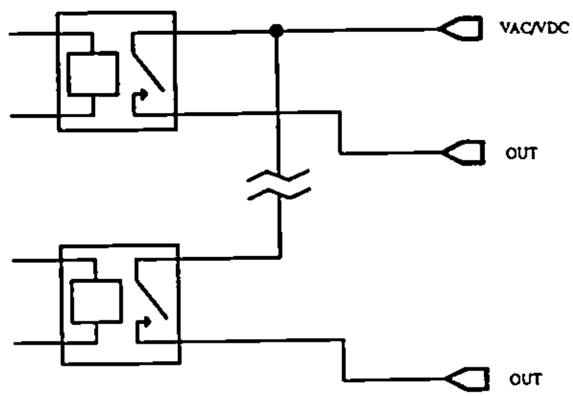


On/Off State Voltage Ranges – All Other Inputs

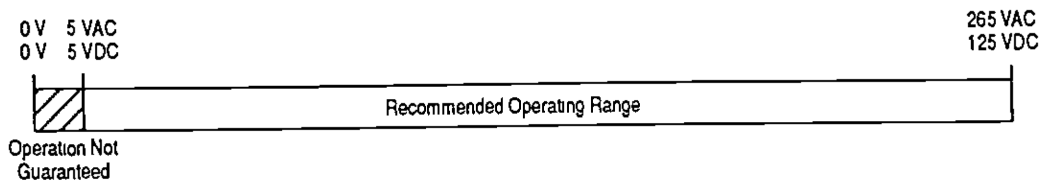


685 617

Output Circuit Diagram

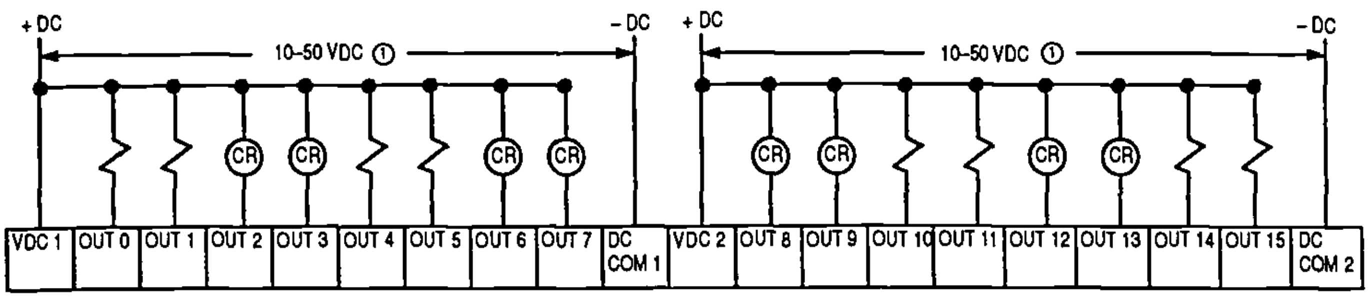


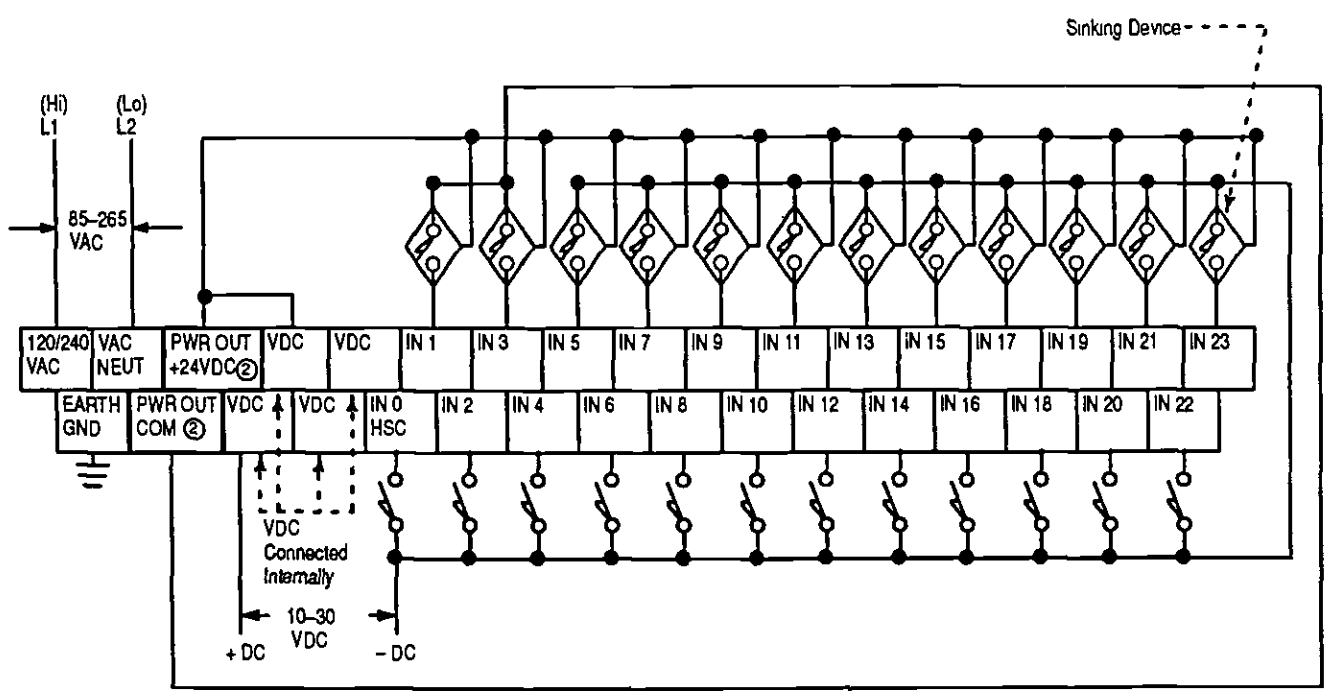
Operating Voltage Range



Catalog Number 1747–L40L (24) 24 VDC Sourcing Inputs, High–Speed Counter Input & (16) Transistor Sinking Outputs

Wiring Diagram



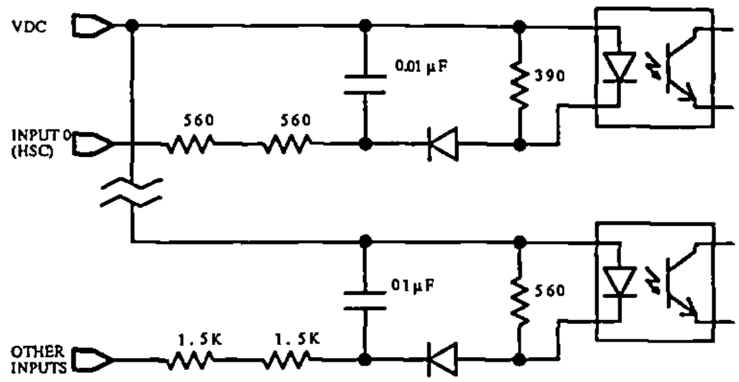


① *The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

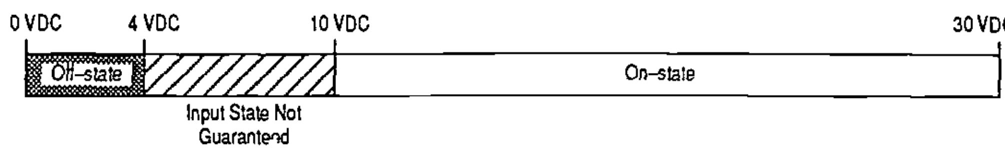
② *24 VDC, 200mA user power is available for sensors.*

685 619

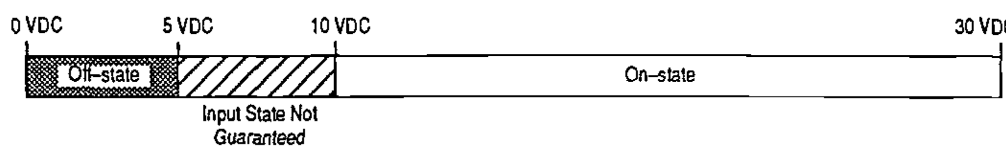
Input Circuit Diagram



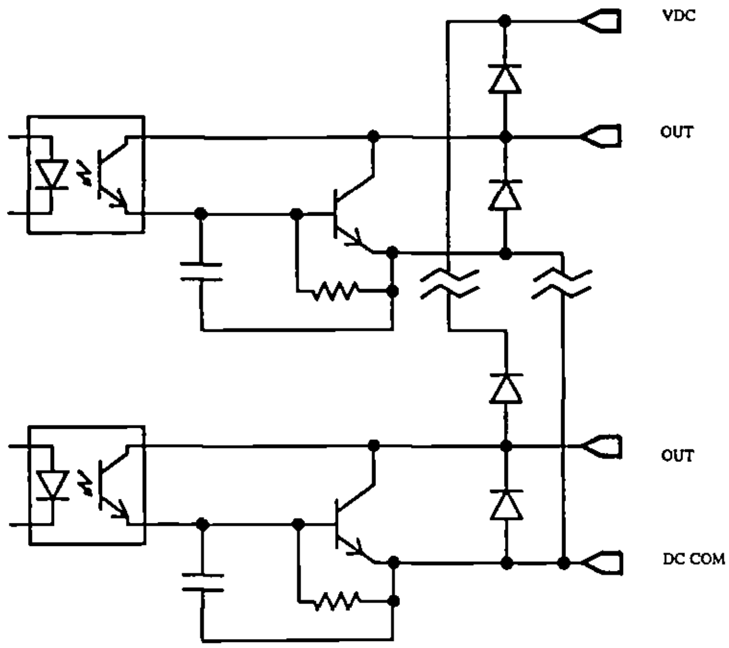
On/Off State Voltage Ranges – Input 0 (HSC)



On/Off State Voltage Ranges – All Other Inputs



Output Circuit Diagram



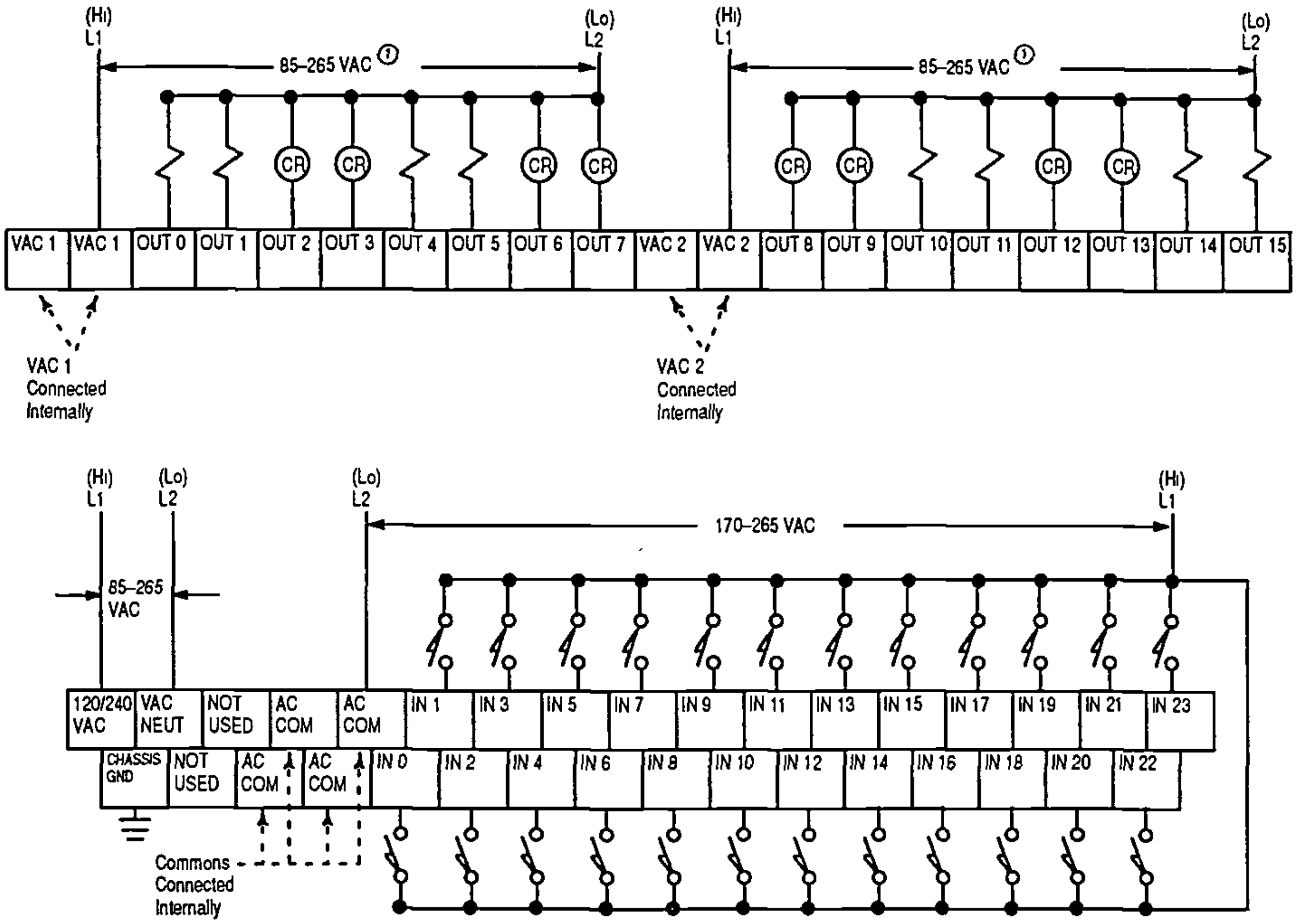
Operating Voltage Range

(Voltage is applied between +VDC and DC common)

685 621

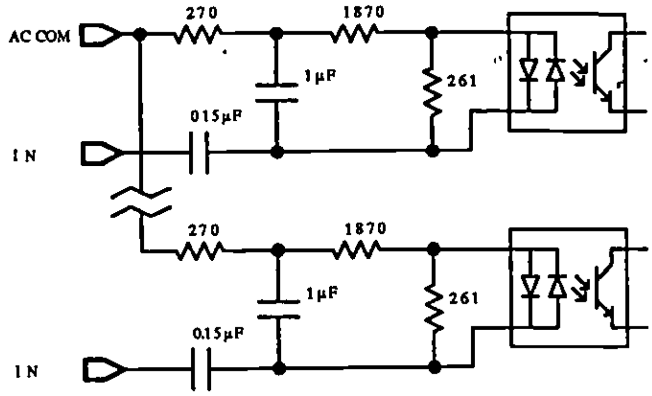
Catalog Number 1747–L40P (24) 240 VAC Inputs & (16) Triac Outputs

Wiring Diagram

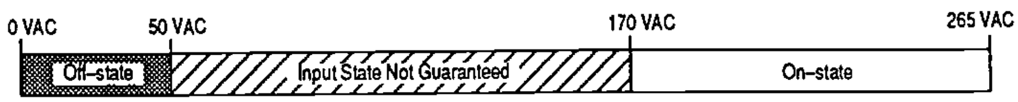


① *The outputs are isolated in groups as shown. Therefore, different voltages can be applied to each group as the specific application requires.*

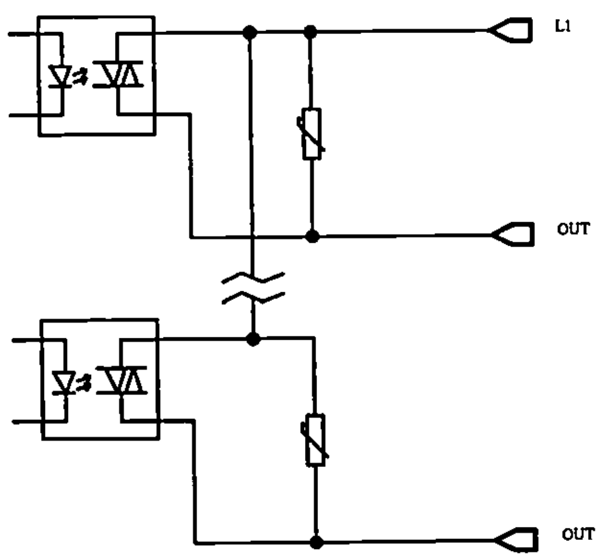
Input Circuit Diagram



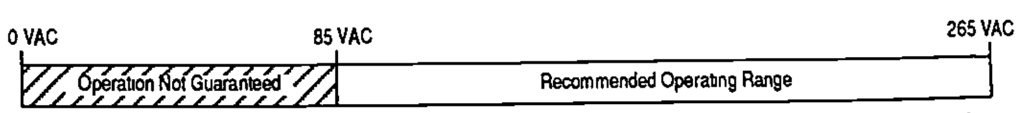
On/Off State Voltage Ranges



Output Circuit Diagram



Operating Voltage Range



Important: If you measure the voltage at an output terminal that is not connected to a load or is connected to a high–impedance load, you may measure as much as 100 VAC even though the output is off

685 623

Glossary

Auto Answer — The type of modem that has self-contained timeouts and tests. They can answer and hang the phone up automatically.

Backplane Current Draw — The amount of current the module requires from the backplane. The sum of the backplane current draw for all modules in a chassis is used to select the appropriate chassis power supply.

Baud Rate — The speed of communication between devices on a network. All devices must communicate at the same baud rate. For example, the DH–485 network devices default to 19,200 baud.

Calculated Watts — The amount of heat generated by those points energized on an I/O module.

Channel — Communication port on a module.

Chassis — A hardware assembly that houses devices such as I/O modules, adapter modules, processor modules, and power supplies.

Continuous Current Per Module — The maximum current for each module. The sum of the output current for each point should not exceed th value.

Continuous Current Per Point — The maximum current each output is designed to continuously supply to a load.

CPU — Central Processing Unit or processor.

DF1 protocol — A peer–to–peer link–layer protocol that combines features of ANSI X3.28–1976 specification subcategories D1 (data transparency) and F1 (two–way simultaneous transmission with embedded responses).

Direct Connect — A type of modem that is connected to a dedicated, leased phone line and is active at all times.

DH–485 Network — The DH–485 network is a collection of devices connected to the communication cable allowing information exchange. A communication network based on the EIA Standard for RS–485 using an Allen–Bradley proprietary protocol.

DTE Controlled Answer — type of modem that is unattended and is attached directly to the phone lines. The interface module or the 5/03 processor acts as the Data Terminal Equipment (DTE), which controls the modem via the DTR, DSR, and DCD signals. The module incorporates timeouts and tests to properly operate these types of modems.

685 624

DTR Dialing (5/03 only) — type of modem that lets you dial a number or end a call based on the status of the RS–232 DTR (Data Terminal Ready) signal. To program the modem initialization string and phone number into the internal memory of the modem, use a dumb terminal (or PC running terminal emulation software like Procomm, Window's Terminal, or PBASE). Once you have programmed the modem, activate the DTR signal to dial the number, or deactivate the DTR signal to end the call.

EEPROM — Electrically Erasable Programmable Read Only Memory module used to store, back up, or transfer SLC 500 programs. The SLC 500 can read and write to an EEPROM.

Flash EPROM — Flash Erasable Programmable Read Only Memory module. It combines the programming versatility of EEPROMs with the security precautions of UVPROMs. This means that you have the option of leaving your EPROM programs write protected or unprotected.

Full–duplex — A high performance protocol that allows simultaneous two–way data transmission. For point–to–point applications only.

Half–duplex — A high performance protocol that can be used in point–to–point and multi–point applications.

Initiator — A node on the DH–485 network capable of acting as a master. When an initiator has the token it can send messages and request replies from any node on the DH–485 network. A personal computer running the SLC 500 Advanced Programming Software is an initiator on the data link. The SLC 5/02 can also be an initiator.

Input Device — A device, such as a push button or a switch, that supplies signals through input circuits to a programmable controller.

Inrush Current — The temporary surge current produced when a device or circuit is initially energized.

I/O — Inputs and Outputs

Isolated Link Coupler — The link coupler provides an electrically isolated network connection for an SLC 500 controller (processor or programming station). The link couplers connect the daisy–chained DH–485 communication cable.

LED — Light Emitting Diode. Used as status indicator for processor functions and inputs and outputs.

Manual — typically an acoustically coupled type of modem. The connection is established by a person on each end of the phone line. They then insert the handsets into an acoustic coupler to complete the connection.

Maximum Watts — The maximum amount of heat that the module generates with field power present.

Minimum Load Current — The lowest amount of current the output is designed to operate at. Operating at or below this value is not reliable.

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Minimum Watts — The amount of heat dissipation that can occur when there is no field power present.

Multi–master network — A network in which more than one node has the ability to initiate communications and initialize the link.

Network — A series of stations (nodes) connected by some type of communication medium. A network may be made up of a single link or multiple links.

Node — Also called a station. An address or software location on the network.

Nominal Input Current — The current at nominal input voltage.

Off–State Current — For input circuits, the maximum amount of leakage current allowed from an input device in its Off–state.

Off–State Leakage — For output circuits, the maximum amount of (leakage) current that may flow when the output circuit is in its Off–state.

Off–State Voltage (max) — The maximum input voltage level detected as an Off condition by the input module.

On–State Voltage Drop — The voltage developed across the output driver circuit during the On state at maximum load current.

Operating Voltage — For inputs, the voltage range needed for the input to be in the On state. For outputs, the allowable range of user–supplied voltage.

Output Device — A device, such as a pilot light or a motor starter coil, that is energized by the programmable controller.

Points per Common — The number of input or output points connected to a single return (common) or supply (vcc).

Protocol — The "language" or packaging of information that is transmitted across a network.

(I/O) Rack — An I/O addressing unit that corresponds to 8 input image–table words and 8 output image–table words. A rack can contain a maximum of 8 I/O groups for up to 128 discrete I/O.

Remote I/O Network — A network where the communication between the processor and the I/O is across a serial link.

Responder —A node on the DH–485 network that acts as a slave device. A responder is not capable of initiating communications. It can only send messages in response to a request from an initiator. The SLC 5/01 and 5/02 can also be responders.

RS–232 — An EIA standard that specifies electrical, mechanical, and functional characteristics for serial binary communication circuits. A single–ended serial communication interface.

RTB —Removable Terminal Block.

Signal Delay — For inputs, the response time required to transmit the circuit status from the field wiring to the digital logic. For outputs, the time required to transmit the circuit status from digital logic to the output wiring.

Sinking — A term used to describe current flow between an I/O device and SLC I/O circuit — typically, a sinking device or circuit provides a path to ground, low, or negative side of power supply.

Sinking/Sourcing — Describes a current signal flow relationship between field input and output devices in a control system and their power supply. Sourcing I/O modules supply (or source) current to sinking field devices. Sinking I/O modules receive (or sink) current from sourcing field devices.

Sourcing — A term used to describe current flow between an I/O device and SLC I/O circuit — typically, a sourcing device or circuit provides a path to the source, high, or positive side of power supply.

Surge Current Per Point — The maximum amplitude and duration (pulse) of current allowed for a given period of time and temperature.

Surge Suppressor — A device used to absorb voltage transients created by energizing an inductive load to reduce electrical noise or to protect the output circuit. For example, an R–C network, MOV (metal oxide varistor) or diode.

Token — The logical right to initiate communications. In a multi–master network a single token is passed between initiators to make sure two nodes do not transmit at the same time.

UVPROM — An Ultra–Violet light erasable Programmable Read Only Memory module used to back up, store, or transfer SLC 500 programs. The SLC 5/01 and 5/02 can only read from a UVPROM. An external PROM programmer is used to program (write to) the device.

Voltage Category — The nominal voltage used to describe the module.

Watts Per Point — The maximum heat dissipation that can occur in each field wiring point when energized.

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Numbers

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Allen-Bradley

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Honeywell

UDC 3000 Universal Digital Controller Product Manual

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About This Publication

w this manual is janized

This Product Manual is divided into 12 sections numbered 1 through 12. These sections contain all the information you need to configure, operate, monitor, and troubleshoot your controller.
To find information quickly, use the comprehensive Table of Contents in the front of the manual and the Index located in the back of the manual.

rranty

The device described herein has been manufactured and tested for correct operation and is warranted as follows:

The UDC3000 Universal Digital Controller carries a two year warranty. This warranty includes immediate technical assistance via a toll free telephone number and complete replacement of the controller, if necessary.

hnical Assistance

If you encounter a problem with your UDC3000 controller, review all the configuration data under the Set-up groups to verify that your selections are consistent with your application; i.e. Inputs, Outputs, Alarms, Limits, etc.
If the problem persists after checking the above, you can get technical assistance by dialing

1-800-423-9883

An engineer will discuss your problem with you. Please have your complete model number, serial number, and Software version available. The model and serial numbers can be found on the chassis nameplate. The software version can be viewed under Setup Group "Status." See Table 9-2.

If it is determined that a hardware problem exists, a replacement controller or part will be shipped with instructions for returning the defective unit. Do not return your controller without authorization from Honeywell's Technical Assistance Center or until the replacement has been received.

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Honeywell
Industrial Automation and Control
Automation College
1100 Virginia Drive
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Table of Contents

Continued on next page

Table of Contents

Continued on next page

Table of Contents

Figures

685 643

Tables

Continued on next page

Tables

685 645

Acronyms

3PSTEP .... 3 Position Step Control
DMCS .... Distributed Manufacturing Control System
EMI .... electromagnetic interference
HID .... high intensity discharge
MOVs .... Metal Oxide Varistors
NC .... normally closed
NO .... normally open
PID .... Proportional, Integral, and Derivative
RC .... resistance-capacitance
RFI .... radio frequency interference
RH .... Relative Humidity
RTD .... Resistance Thermometer Device
SCRs .... Silicon controlled rectifiers
UDC .... Universal Digital Controller

Parameters

2IN .... Input 2
2SP .... Local Setpoint 2
A1S1 EV .... SP Programming Event Alarm State for Alarm 1, Setpoint 1
A1S1 VAL .... Alarm 1, Setpoint 1
A1S1TYPE .... Alarm 1, Setpoint 1 Type
A1S2 EV .... SP Programming Event Alarm State for Alarm 1, Setpoint 2
A1S2 HL .... Alarm 1, Setpoint 2 State
A1S2 VAL .... Alarm 1, Setpoint 2
A1S2TYPE .... Alarm 1, Setpoint 2 Type
A2S1 EV .... SP Programming Event Alarm State for Alarm 2, Setpoint 1
A2S1 HL .... Alarm 2, Setpoint 1 State
A2S1 VAL .... Alarm 2, Setpoint 1
A2S1TYPE .... Alarm 2, Setpoint 1
A2S2 EV .... SP Programming Event Alarm State for Alarm 2, Setpoint 2
A2S2 HL .... Alarm 2, Setpoint 2 State
A2S2 VAL .... Alarm 2, Setpoint 2
A2S2TYPE .... Alarm 2, Setpoint 2 Type
ACTION .... Control Output Direction
ADAPTIVE .... Adaptive Tune
AL HYST .... Alarm Hysteresis
AT ERROR .... Adaptive Tune Error codes
AUTO .... Lower display automatically displays setpoint value in engineering units
AUTO MAN .... Manual/Auto Key Lockout
AUX OUT .... Auxiliary Output Representation
BAUD .... Baud Rate
BIAS IN1 .... Input 1 Bias
CAL MTR .... suggests that the controller be calibrated
CAL TEST .... Calibration test failure
Com ADDR .... Communications Station Address
ComSTATE .... Communications Option State
CONF ERR .... configuration error
CONFTEST .... Configuration test failure
CONT ALG .... Control Algorithm
CSP .... Computer Setpoint Override
CYC SEC .... Cycle Time
CYC2 SEC .... Cycle Time 2 (Cool)

Parameters, continued

DEADBAND	Output Relay Deadband
DEV	Deviation
DIG 1 COM	Digital Input 1 Combinations
DIG 2 COM	Digital Input 2 Combinations
DIG IN 1	Digital Input 1 selections
DIG IN 2	Digital Input 2 selections
DROPOFF	Controller Dropoff Value
DUPLEX	Duplex Operation
E E FAIL	Unable to write to non-volatile memory
EMSSIV	Emissivity
END SEG	End Segment Number
EU/HR DN	Rate Down Value
EU/HR UP	Rate Up Value
FACT CRC	Factory Calibration Cyclic Redundancy test
FAILSAFE	Controller in Failsafe
FAILSAFE	Failsafe Output Value
FILTER 1	Input 1 Filter
FILTER2	Input 2 Filter
FINAL SP	Single Setpoint Final Setpoint
GAIN	Gain
GAIN2	Gain 2
IN1 HI	Input 1 High Range Value
IN1 LO	Input 1 Low Range Value
IN1 TYPE	Input 1 Actuation Type
IN2HI	Input 2 High Range Value
IN2LO	Input 2 Low Range Value
INP1 RNG	Input 1 Out of Range
INP1FAIL	Two consecutive failures of Input 1 integration
INP2 RNG	Input 2 Out of Range
INP2FAIL	Two consecutive failures of Input 2 integration
KPG	Process Gain
LOCKOUT	Configuration Lockout
LOOPBACK	Local Loop Back
MAN	Lower display automatically indicates output in %.
MAN RSET	Manual Reset
MINorRPM	Reset Units
OUT ALG	Output Algorithm
OUT HYST	Output Relay Hysteresis
OUT	Output Value
OUT RATE	Output Change Rate
OUTHILIM	High Output Limit
OUT	Low Output Limit
PARITY	Parity
PBorGAIN	Proportional Band or Gain Units
PCT/MIN	Output Rate
PCT/MIN	Output Rate
PID SETS	Tuning Parameter Sets
PIDSETX	Tuning Parameter Set
POS	Motor Position
PROG END	Program Termination State
PROP BD	Proportional Band
PROP BD2	Proportional Band 2
PV LIMIT	PV Out of Range
PWR FREQ	Power Line Frequency

685 647

Parameters, continued

RAM TEST	RAM test failed
RAMPUNIT	Engineering units for ramp segments
RAMPXXOM	*Minutes remaining in Setpoint Ramp*
RATE MIN	Rate in Minutes
RATE2MIN	Rate 2 in Minutes
RECYCLES	Number of Program Recycles
RLY TYPE	Output Relay Type
RSET MIN	Reset in minutes/repeat
RSET RPM	Reset in repeats/minute
RSET2MIN	Reset 2 in minutes/repeat
RSET2RPM	Reset 2 in repeats/minute
RSP	Remote Setpoint
RSP SRC	Remote Setpoint Source
RUN HOLD	Run/Hold key
RV LIMIT	Remote Variable Out of Range
SECURITY	Security Code
SEG 1 rate	Segment #1 Ramp Rate
SEG1 ramp	Segment #1 Ramp Time
SHED SP	Shed Setpoint Recall
SHEDMODE	Shed Controller Mode and Output Level
SHEDTIME	Shed Time
SOAK DEV	Guaranteed Soak Deviation Value
SP CHANG	Setpoint Change
SP HILIM	Setpoint High Limit
SP	Local Setpoint 1
SP LOLIM	Setpoint Low Limit
SP PROG	Setpoint Programming
SP PROG	Setpoint Ramp/Soak Programming
SP RAMP	Setpoint Ramp selection
SP RAMP	Single Setpoint Ramp
SP RATE	Setpoint Rate
SP SEL	Setpoint Select
SP SOURC	Local Setpoint Source
SP TRACK	Local Setpoint Tracking
SPn	Setpoint Now
STATE	Program state at program end
STRT SEG	Start Segment Number
SW FAIL	Auto Cal never performed.
SW FAIL	Position Proportional slidewire input failure
SW VALUE	Automatic Switchover Value
TIME MIN	Single Setpoint Ramp Time
UNITS	Communication Units
XMITTER	Transmitter Characterization
XMITTER2	Transmitter Characterization Input 2

References

Publication Title	Publication Number
UDC3000 Limit Controller	51-52-25-09
UDC3000/UDC5000/UDC6000 RS422/485 Communications Option Manual	51-51-25-35
UDC3000 DMCS Communications option Section of the Gateway Manual	82-50-10-23

685 649

Section 1 – Overview

1.1 Introduction

Function

The UDC3000 Universal Digital Controller is a microprocessor-based stand alone controller. It combines the highest degree of functionality and operating simplicity offered in a 1/4 DIN size controller.
With a typical accuracy of ±0.20% of span, the UDC3000 is an ideal controller for regulating temperature and other process variables in numerous heating and cooling applications, in metal working, food, and pharmaceuticals, and testing and environmental work.

Easy to read displays

The dedicated vacuum fluorescent displays with English prompts make the operator interface easy to read, understand and operate.
Programmed sequences of displays assure quick and accurate entry of all configurable parameters.

Easy to operate

Simple keystrokes let you select input and range configuration, set the operating parameters that meet your process control needs now, and change them later to meet new ones.
The tactile keyboard provides positive operator feedback. Self diagnostics, fault tolerant design and keyboard security provide maximum assurance of trouble-free operation.

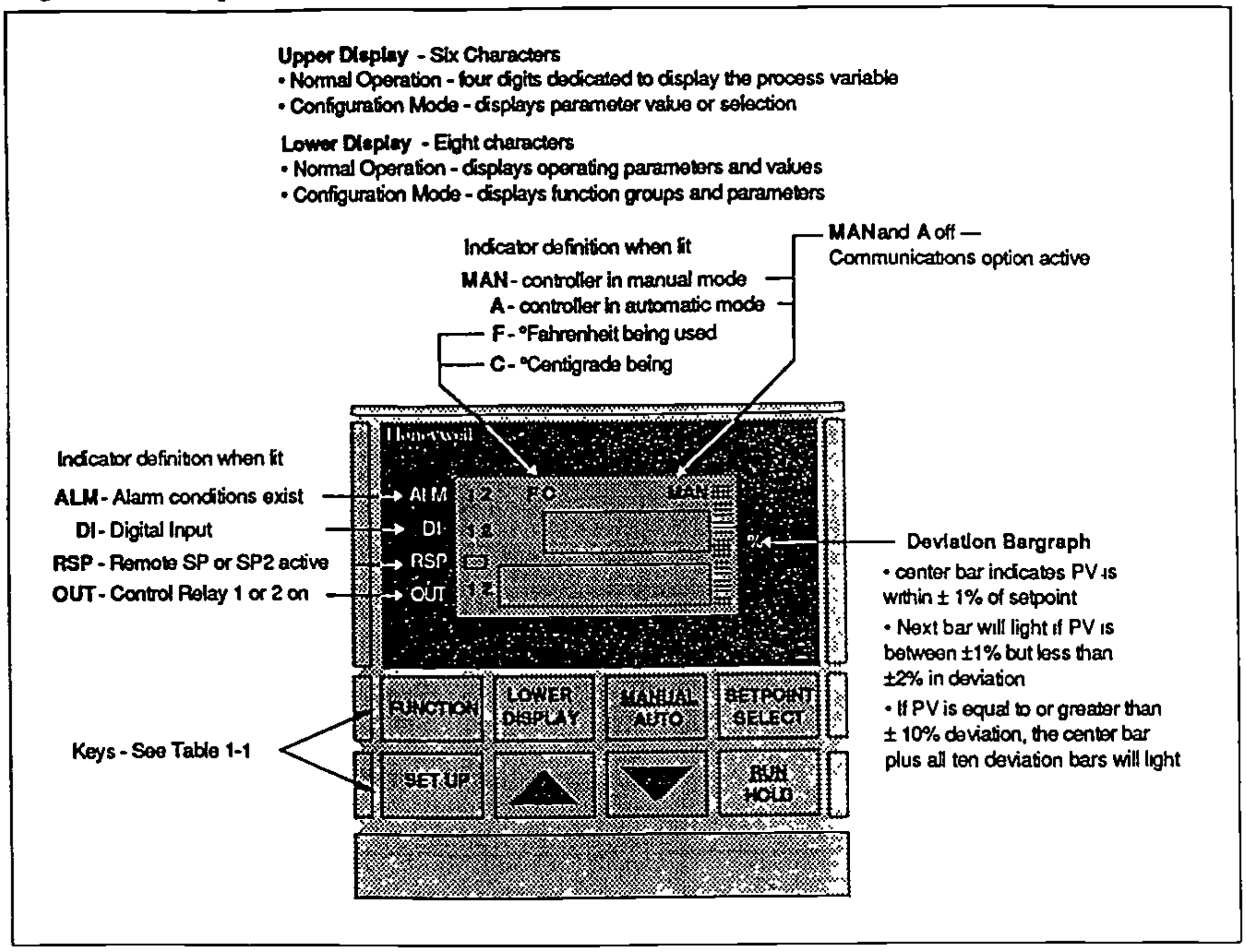
Mount anywhere

The UDC is environmentally hardened and can be mounted virtually anywhere in plant or factory; on the wall, in a panel, or even on the process machine. It withstands ambient temperatures up to 55°C and resists the effects of vibration and mechanical shock.

1.2 Operator Interface

Displays and Indicators Figure 1-1 shows the operator interface and defines the displays and indicators. The function of the keys is shown in Table 1-1.

Figure 1-1 Operator Interface Displays and Indicators



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685 651

1.2 Operator Interface, Continued

Function of keys

Table 1-1 shows each key on the operator interface and defines its function.

Table 1-1 Function of Keys

Key	Function
SET UP	• Places the controller in the Configuration Set Up group select mode. Sequentially displays Set Up groups and allows the [FUNCTION] key to display individual functions in each Set Up group.
FUNCTION	• Used in conjunction with the [SET UP] key to select the individual functions of a selected Configuration Set Up group. • Used during field calibration procedure.
LOWER DISPLAY	• Selects an operating parameter to be shown in the lower display: SP = Local Setpoint 1 2SP = Local Setpoint 2 RSP = Remote Setpoint 2IN = Input 2 DEV = Deviation RAMPXXOM = Minutes remaining in Setpoint Ramp PIDSETX = Tuning Parameter Set X=1 or 2 OUT = Output Value* CSP = Computer Setpoint Override SPn = Setpoint Now (for setpoint rate) POS = 3 Position Step motor position when slidewire is connected * or estimated 3 Position Step motor position when no slidewire exists.
MANUAL AUTO	• Alternately selects: AUTO Lower display automatically displays setpoint value in engineering units. MAN Lower display automatically indicates output in %.
SETPOINT SELECT	• Alternately selects Local Setpoint 1 and Remote Setpoint or between the two local setpoints.
RUN HOLD	• Alternate action switch initiates or holds the Setpoint Ramp or Setpoint Program. • Restores the original value or selection if you do not want to enter a change you are making to a parameter.
▲	• Increases the setpoint, output, or configuration values displayed.
▼	• Decreases the setpoint, output, or configuration values displayed

685 652

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685 653

Section 2 – Installation

2.1 Overview

Introduction

Installation of the UDC 3000 Controller consists of mounting and wiring the controller according to the instructions given in this section. Read the pre-installation information, check the model number interpretation and become familiar with your model selections, then proceed with installation.

What's in this section?

This section contains the following information:

Continued on next page

2.1 Overview, Continued

Pre-Installation Information

If the controller has not been removed from its shipping carton, inspect th carton for damage and remove the controller. Inspect the unit for any obvious shipping damage and report any damage due to transit to the carrier.
Make sure a bag containing mounting hardware is included in the carton with the controller.
Check that the model number shown on the inside of the case agrees with what you have ordered.

Operating limits

We recommend that you review and adhere to the operating limits listed in Table 2-1 when you install your controller.

Table 2-1 Operating Limits

Condition	Specifications
Ambient Temperature	32 to 131°F (0 to 55°C)
Relative Humidity	5 to 90% RH at 40°C (104°F)
Vibration Frequency Acceleration	 0 to 200Hz 0.2g
Mechanical Shock Acceleration Duration	 5g 30ms
Power	90 to 264 Vac 50/60 Hz (CSA models rated to 250V Maximum)
Power Consumption	18VA Maximum

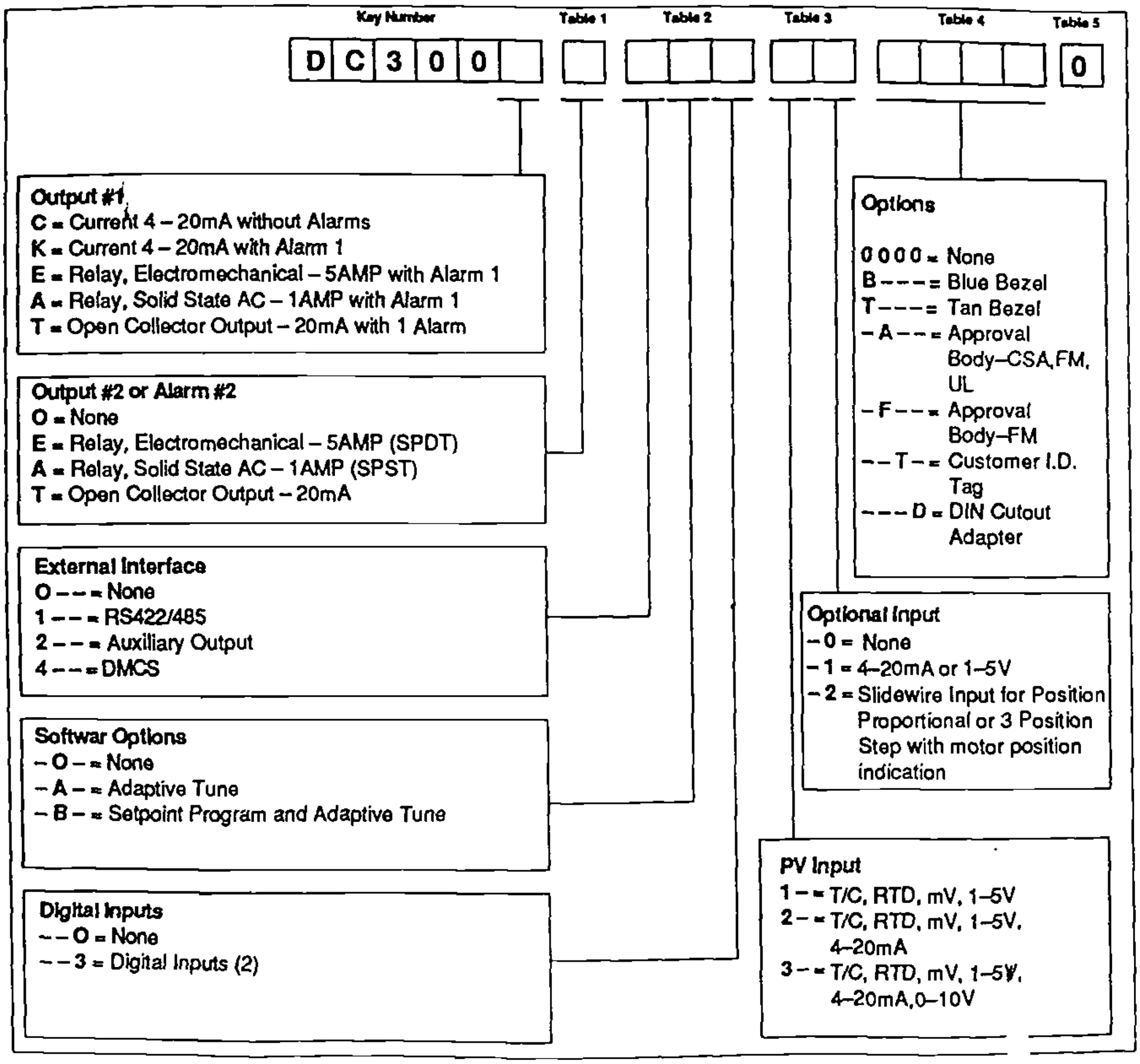
685 655

2.2 Model Number Interpretation

Model number

The model number interpretation is shown in Figure 2-1. Write the model number into the spaces provided and compare it to the model number interpretation. This information will also be useful when you wire your controller.

Figure 2-1 Model Number Interpretation



2.3 Mounting

Physical considerations

The controller can be mounted on either a vertical or tilted panel using the mounting kit supplied. Adequate access space must be available at the bac of the panel for installation and servicing activities.

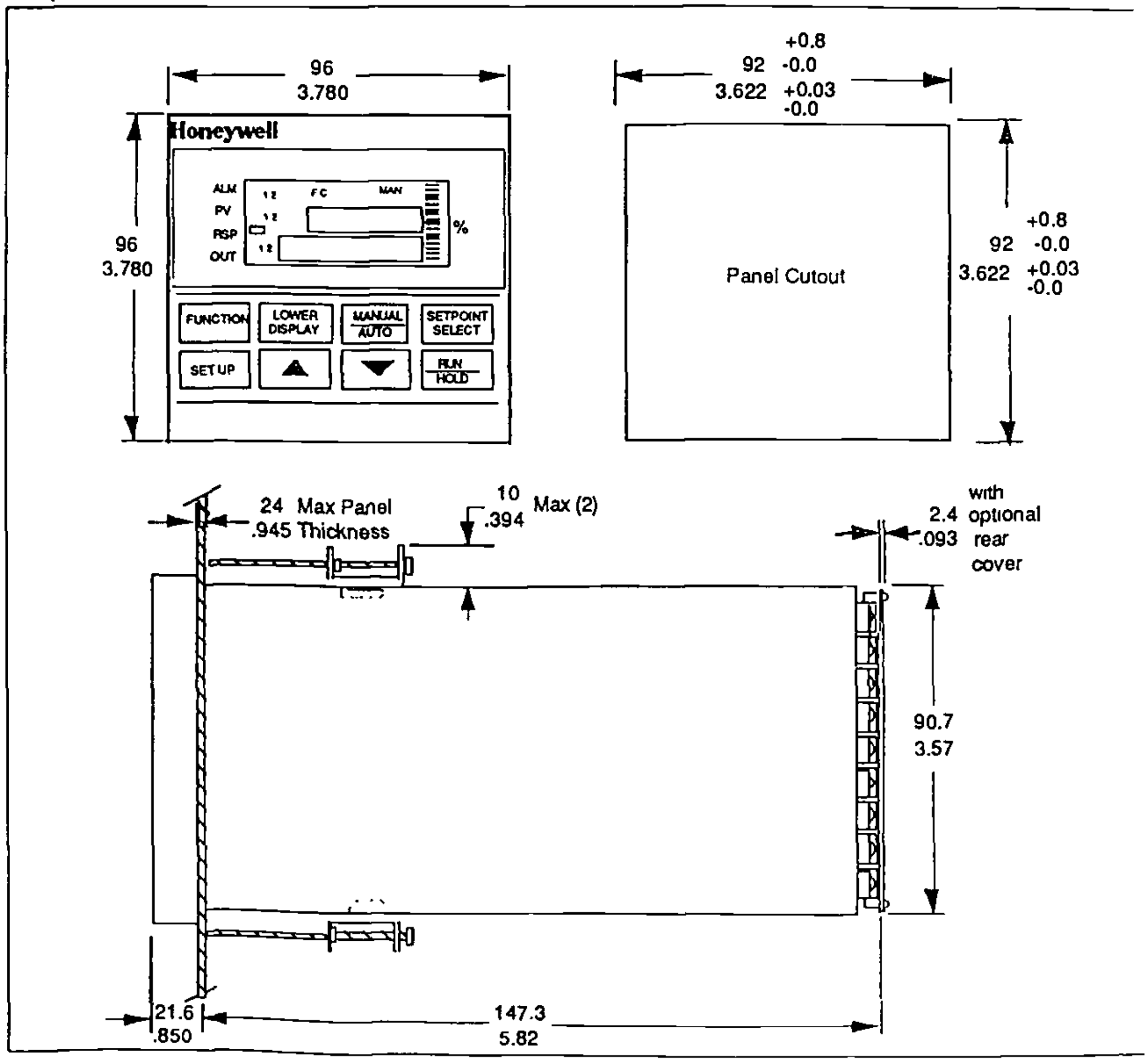
The overall dimensions and panel cutout requirements for mounting the controller are shown in Figure 2-2.

The controller's mounting enclosure must be grounded according to CSA standard C22.2 No. 0.4 or Factory Mutual Class No. 3820 paragraph 6.1.5.

Overall dimensions

Figure 2-2 shows the overall dimensions for mounting the controller.

Figure 2-2 Dimensions



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685 657

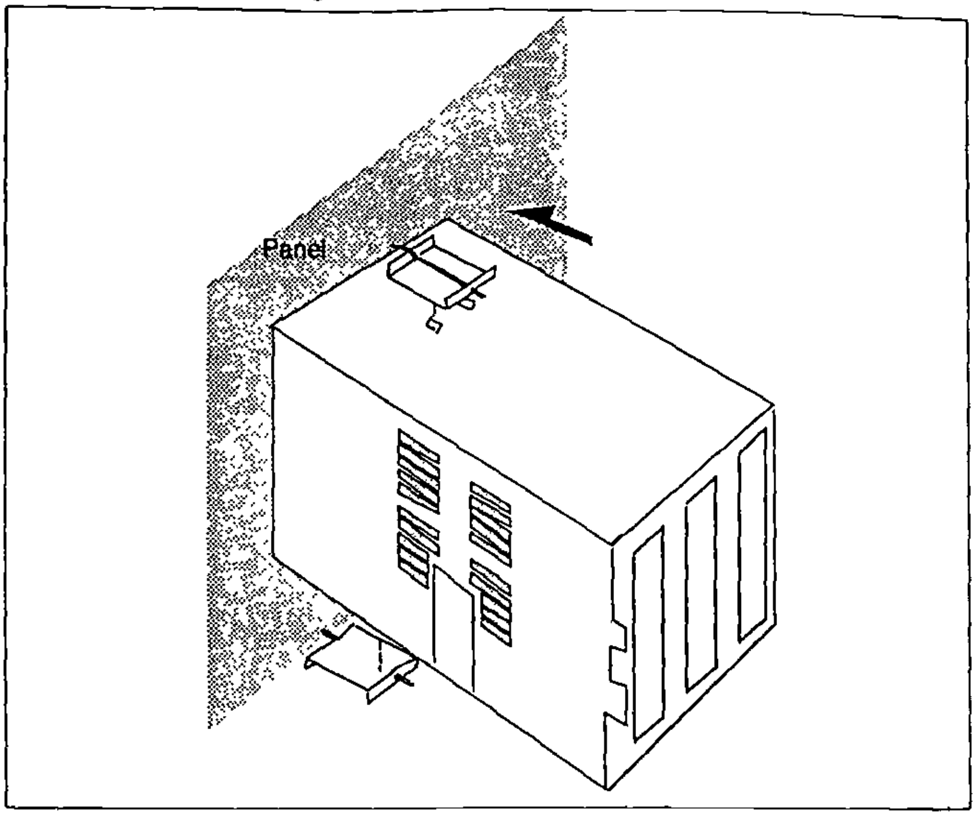
2.3 Mounting, Continued

Mounting method

Before mounting the controller, refer to the nameplate on the inside of the case and make a note of the model number. It will help later when selecting the proper wiring configuration.

Figure 2-3 shows you the mounting method for the UDC3000 controller.

Figure 2-3 Mounting Method



Mounting procedure

Refer to Figure 2-3 and follow the procedure below to mount the controller.

Step	Action
1	Mark and cut out the controller hole in the panel according to the dimension information in Figure 2-2.
2	Remove the screw cover and loosen the screw on the front of the controller. Pull the chassis out of the case.
3	Orient the case properly and slide it through the panel hole from the front.
4	Remove the mounting kit from the shipping container, and install the kit as follows: • Install the screws into the threaded holes of the clips • Insert the prongs of the clips into the two holes in the top and bottom of the case. • Tighten both screws to secure the case against the panel • Carefully slide the chassis assembly into the case, press to close and tighten the screw Replace the screw cover

2.4 Wiring

Taking electrical noise precautions

Electrical noise is composed of unabated electrical signals which produce undesirable effects in measurements and control circuits.

Digital equipment is especially sensitive to the effects of electrical noise. Your controller has built-in circuits to reduce the effect of electrical noise from various sources. If there is a need to further reduce these effects:

- Separate External Wiring - separate connecting wires into bundles (see Table 2-2) and route the individual bundles through separate conduits metal trays.
- Use Suppression Devices - for additional noise protection, you may want to add suppression devices at the external source. Appropriate suppression devices are commercially available.

NOTE For additional noise information, refer to *Section 12*.

Permissible wire bundling

Table 2-2 shows which wire functions should be bundled together.

Table 2-2 Permissible Wiring Bundling

Bundle No.	Wire Functions
1	• Line power wiring • Earth ground wiring • Control relay output wiring • Line voltage alarm wiring
2	Analog signal wire, such as: • Input signal wire (thermocouple, 4 to 20 mA, etc.) • 4-20mA output signal wiring • Slidewire feedback circuit wiring • Digital input signals • Communications
3	• Low voltage alarm relay output wiring • Low voltage wiring to solid state type control circuits

Continued on next page

685 659

2.4 Wiring, Continued

Identify your wiring requirements

To determine the appropriate diagrams for wiring your controller, refer to the model number interpretation in this section. The model number of the controller can be found on the inside of the case.

Wiring the controller

Using the information contained in the model number, select the appropriate wiring diagrams from the figures listed below and wire the controller accordingly.

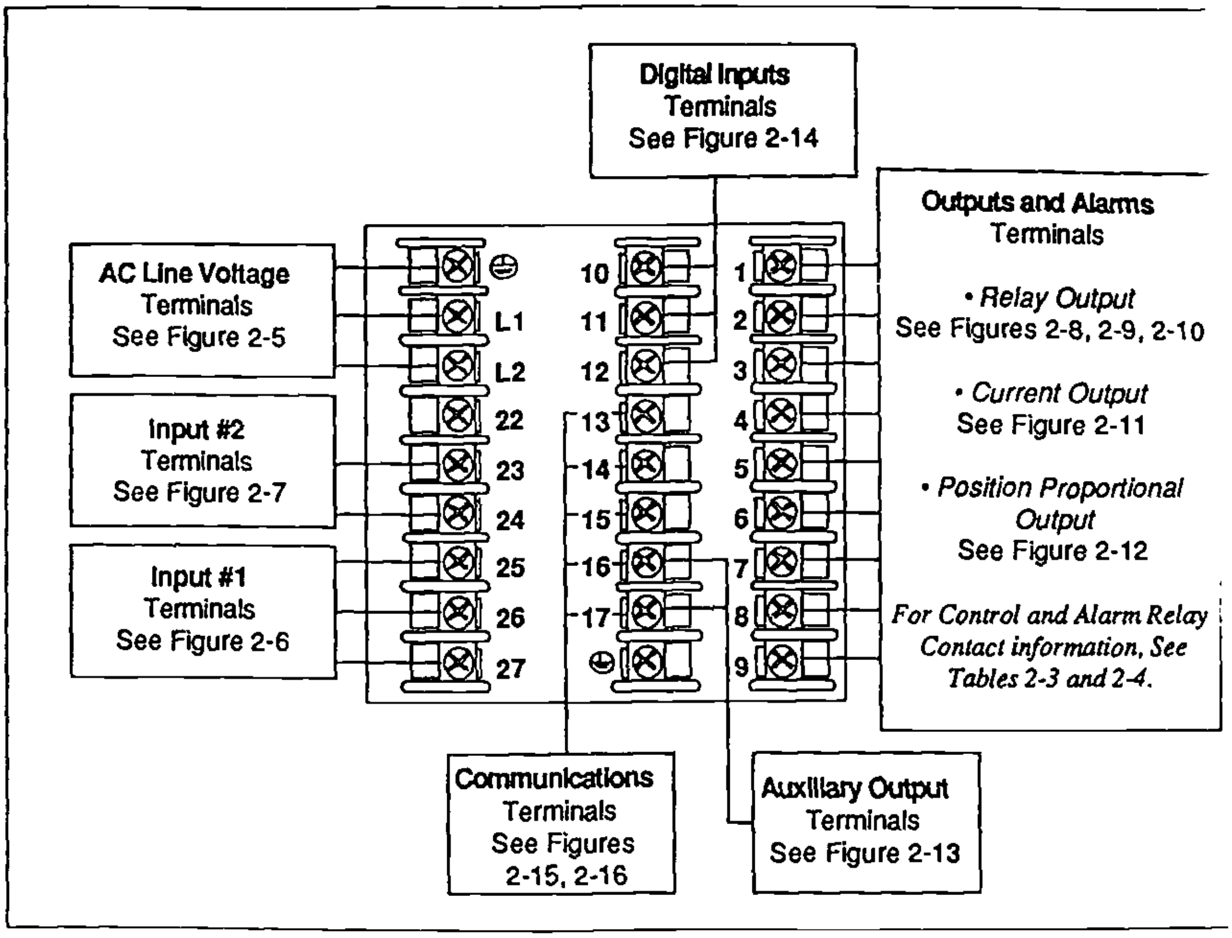
Wiring Requirements	Figure
Composite Wiring Diagram	2-4
Line Power 90–264 Vac	2-5
Input #1 Wiring	2-6
Input #2 Wiring	2-7
Relay Output	
• Electromechanical Relay Output	2-8
• Solid State Relay Output	2-9
• Open Collector Output	2-10
Current Output	2-11
Position Proportional Output	2-12
Auxiliary Output wiring	2-13
Communications Wiring	
• RS422	2-14
• DMCS	2-16
Digital Inputs Wiring	2-17

2.5 Wiring Diagrams

Composite wiring diagram

Figure 2-4 is a composite wiring diagram of the UDC3000 controller. . identifies the terminal designations and their functions. Refer to the individual diagrams listed to wire the controller according to your requirements.

Figure 2-4 Composite Wiring Diagram



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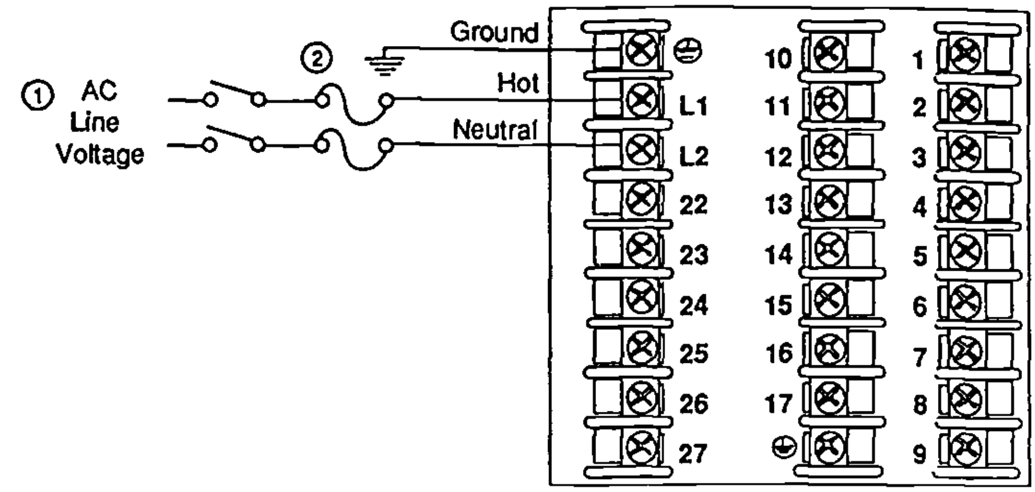
685 661

2.5 Wiring Diagrams, Continued

Line voltage wiring Figure 2-5 shows the wiring connections for the line voltage.

Figure 2-5 Line Voltage Wiring



① AC Line Voltage, 90 – 264 Volts Ground separately and directly to earth. Ground using 12 gauge stranded wire.

② External Slow Blow fuses or circuit breakers must be rated at 1/2 Amp, 250Vac

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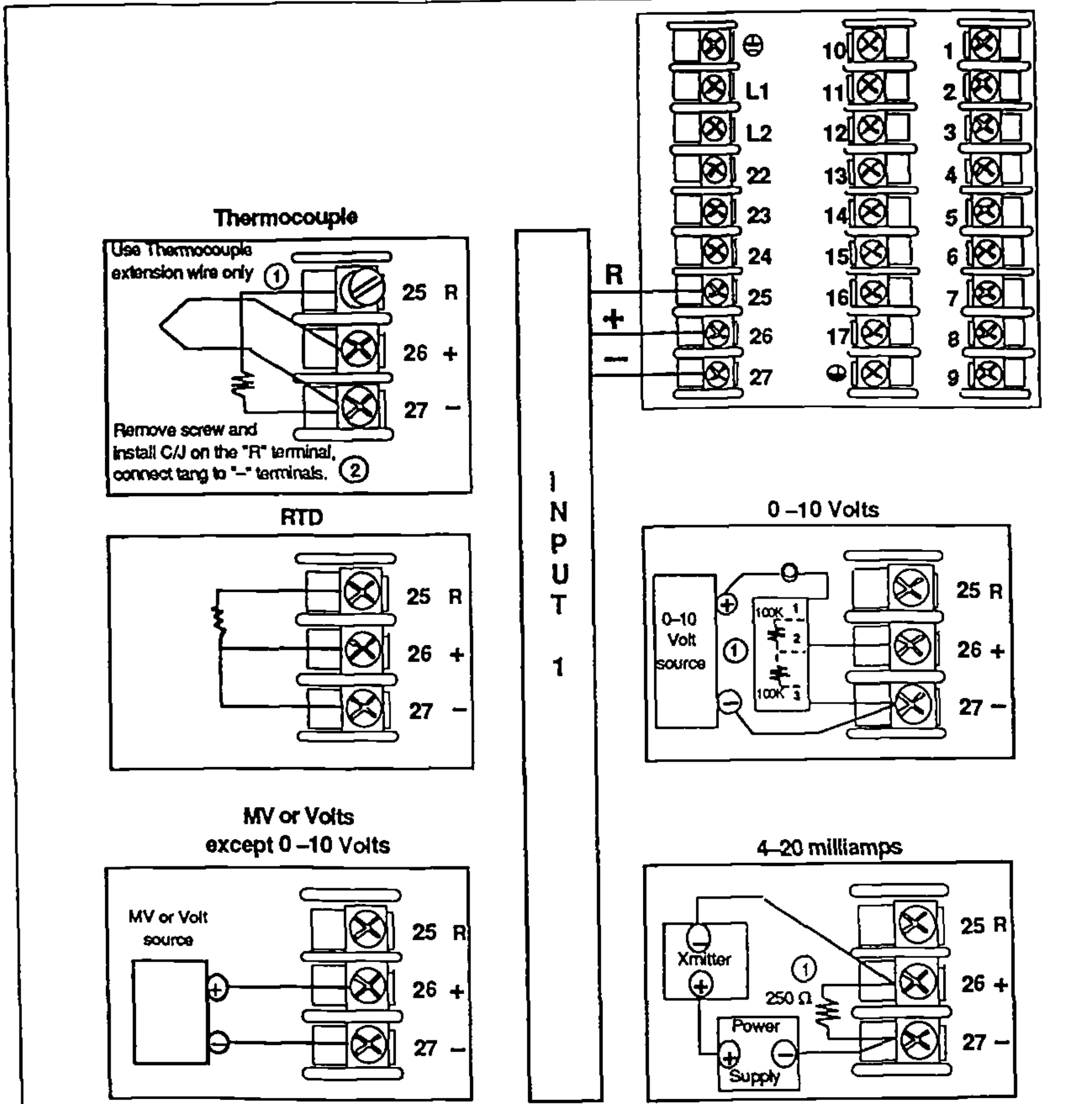
2.5 Wiring Diagrams, Continued

Input #1 connections Figure 2-6 shows the wiring connections for Input #1.

Figure 2-6 Input #1 Connections



① The 250 Ω load resistor for 4–20mA or the Voltage divider for 0–10 Volts or the 500 Ohm C/J compensation resistor are supplied with the controller when the input is specified. These items must be installed when you wire the controller before startup

② When installing the cold junction (Part number 30754499-006) for a T/C input, remove the screw from terminal 25 and install the threaded end of the assembly into its place

Continued on next p

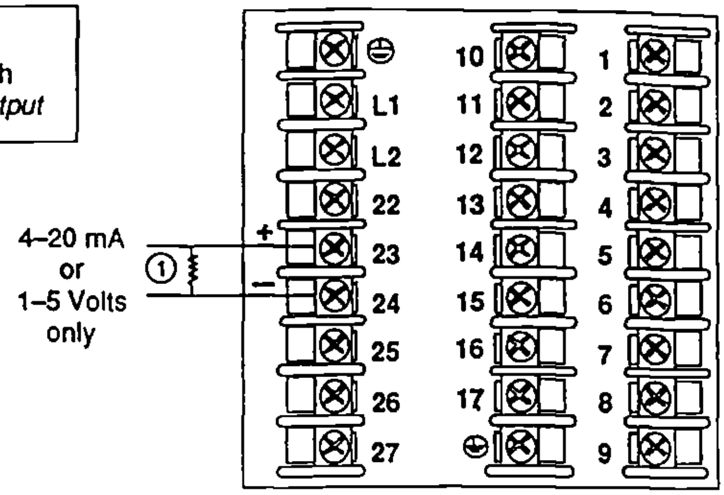
685 663

2.5 Wiring Diagrams, Continued

Input #2 connections Figure 2-7 shows the wiring connections for Input #2.

Figure 2-7 Input #2 Connections

ATTENTION:
Input #2 not available with *Position Proportional Output*



① 4–20 mA requires a 250 Ω resistor which is supplied with the controller. It must be installed when wiring the controller before startup.

Continued on next page

685 664

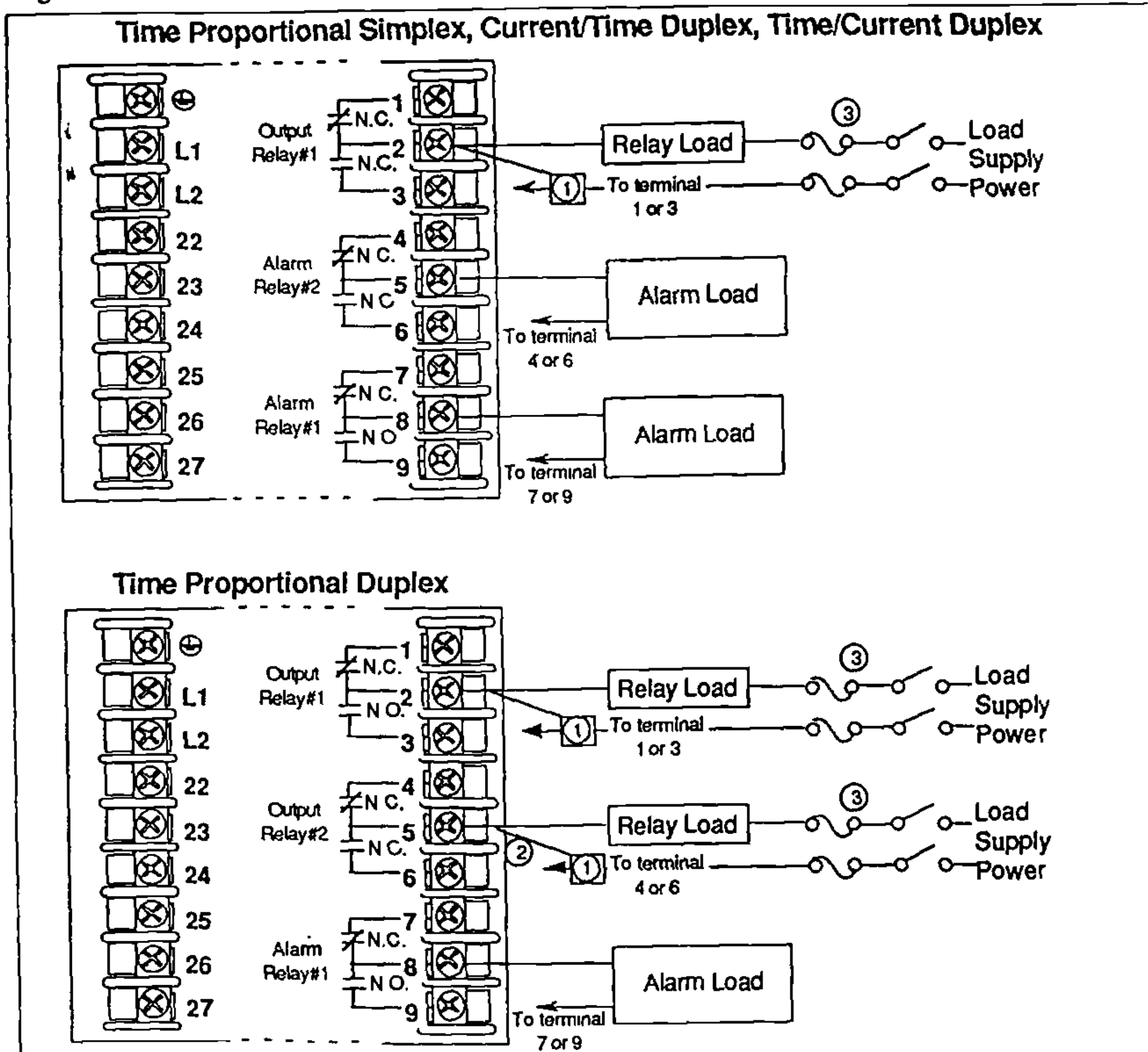
2.5 Wiring Diagrams, Continued

Relay output

There are three types of relay outputs available on the UDC 3000.
- Electromechanical Relay Output – Figure 2-8
- Solid State Relay Output – Figure 2-9
- Open Collector Output – Figure 2-10

The Alarm wiring connections are the same for all three outputs.
For Control and Alarm Relay Contact information, see Tables 2-3 and 2-4.
Figure 2-8 shows the Output and Alarm wiring connections for models wi[th] Electromechanical Relay Output.

Figure 2-8 Electromechanical Relay Output



① Snubber assembly is supplied by Honeywell

② Alarm #2 not available with Time Proportional Duplex or Three Position Step Control or Position Proportional Control

③ Electromechanical relays are rated at 5 Amps@ 120Vac or 2.5 Amps at 240Vac
Customer should size fuses accordingly

Continued on next page

685 665

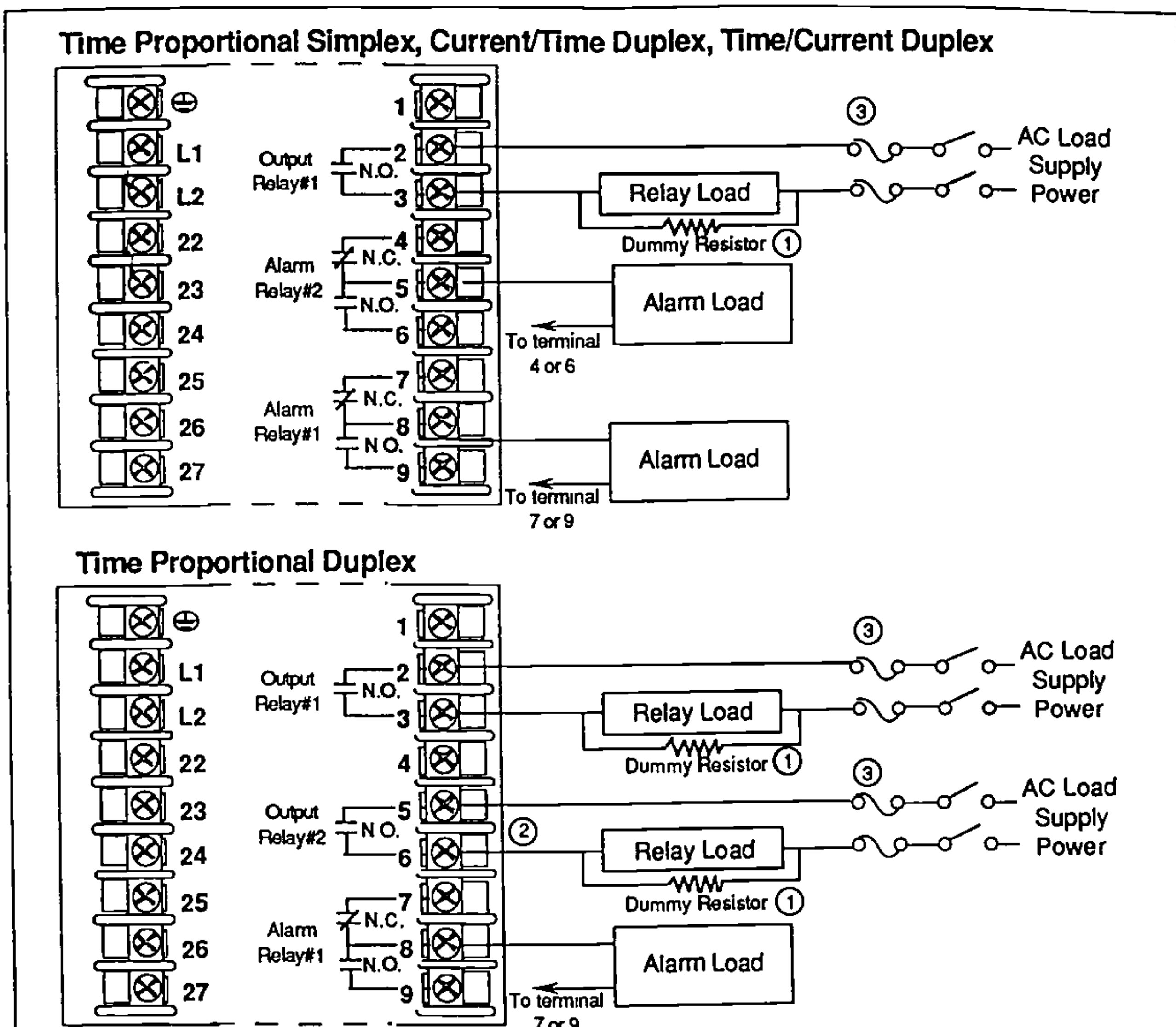
2.5 Wiring Diagrams, Continued

Relay output (continued)

Figure 2-9 shows the Output and Alarm wiring connections for models with Solid State Relay Output.

For Control and Alarm Relay Contact information, see Tables 2-3 and 2-4.

Figure 2-9 Solid State Relay Output



① If the load current is less than the minimum rated value of 20mA, there may be a residual voltage across both ends of the load even if the relay is turned off. Use a dummy resistor as shown to counteract this The total current through the resistor and the load current must exceed 20mA

② Alarm #2 not available with Time Proportional Duplex or Three Position Step Control or Position Proportional control

③ Solid State relays are rated at 0 5 Amps Customer should size fuses accordingly.

Continued on next page

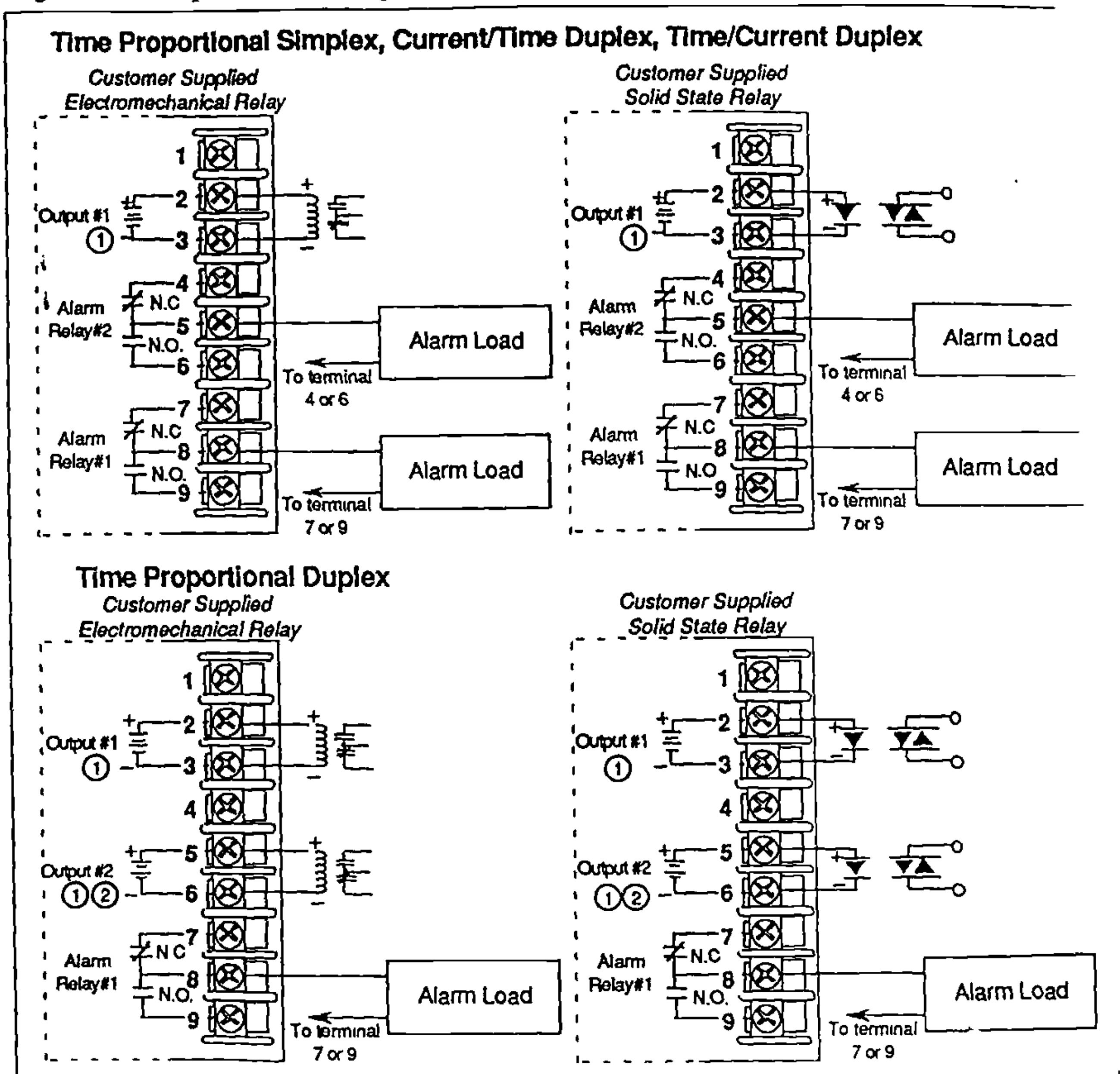
2.5 Wiring Diagrams, Continued

Relay Output (continued)

Figure 2-10 shows the Output and Alarm wiring connections for model: with Open Collector Output.

For Control and Alarm Relay Contact information, see Tables 2-3 and 2-4.

Figure 2-10 Open Collector Output



① WARNING Open collector outputs are internally powered. Connecting an external supply will damage the controller.

② Alarm #2 not available with Time Proportional Duplex or Three Position Step Control or Position Proportional control

Continued on next page

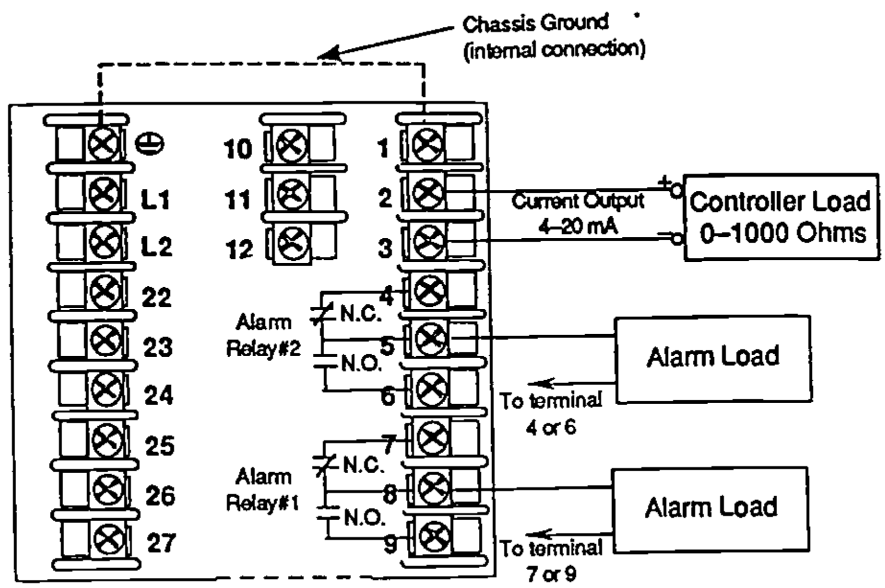
685 667

Current output connections

Figure 2-11 shows the Output and Alarm wiring connections for models with Current Output.

For Control and Alarm Relay Contact information, see Tables 2-3 and 2-4.

Figure 2-11 Current Output, Current /Time Duplex, and Time/Current Duplex



For Duplex Current Output use Auxiliary Output for Output 2 (cool)

Continued on next page

2.5 Wiring Diagrams, Continued

Position proportional output connections

Figure 2-12 shows the Output and Alarm wiring connections for models with Position Proportional Output.

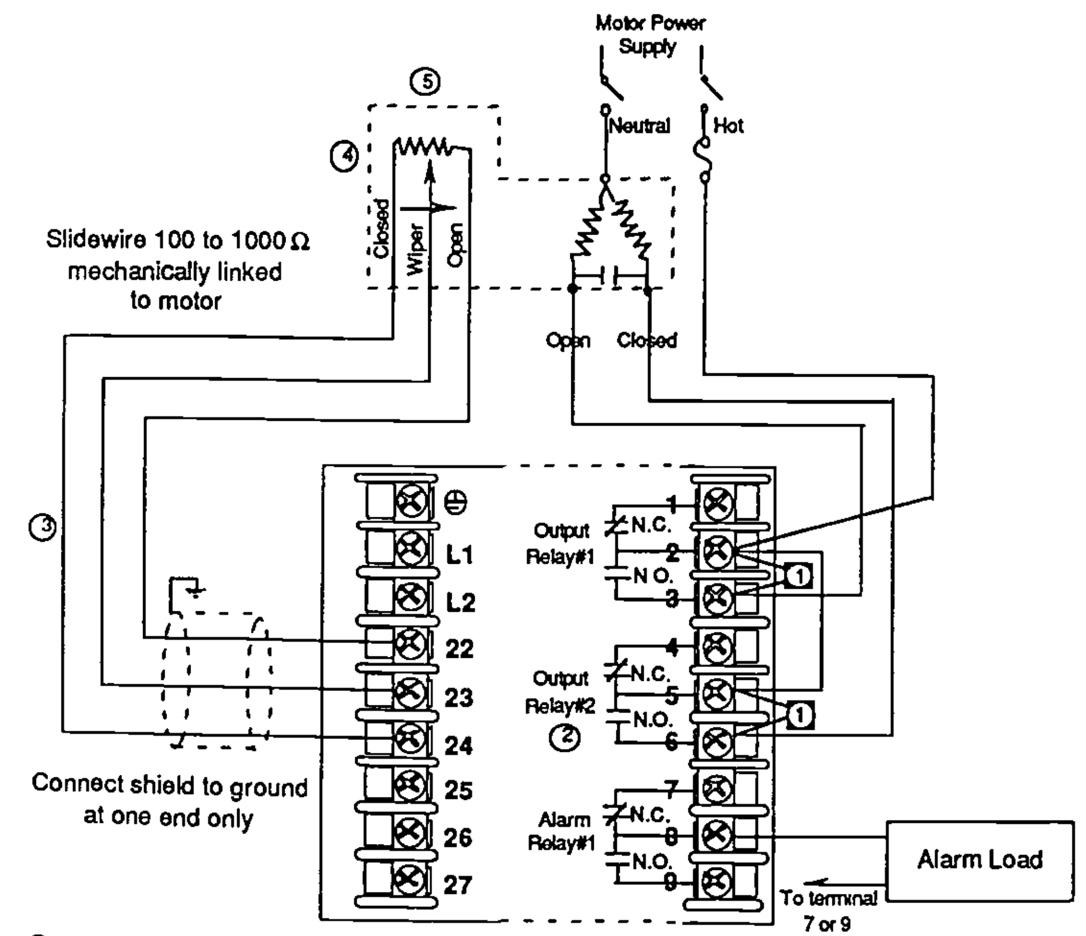
For Control and Alarm Relay Contact information, see Tables 2-3 and 2-4.

Calibration

Position Proportional Output or *Three Position Step* models must have the output calibrated after installation (see *Section 8—Position Proportional Output Calibration*) to ensure that the displayed output (slidewire position) agrees with the actual final control element position.

Three Position Step models only require that the motor time be entered. Full calibration is not required.

Figure 2-12 Position Proportional Output or Three Position Step



1. Snubber assemblies supplied by Honeywell for electromechanical relays only.
2. Alarm #2 not available with Time Proportional Duplex, Position Proportional output or Three Position Step control
3. Do not run slidewire cable in the same conduit as AC power.
4. Electrical noise suppression may be required. *Refer to Section 12.*
5. Slidewire input not required for 3 Position Step control but can be used for motor position indication

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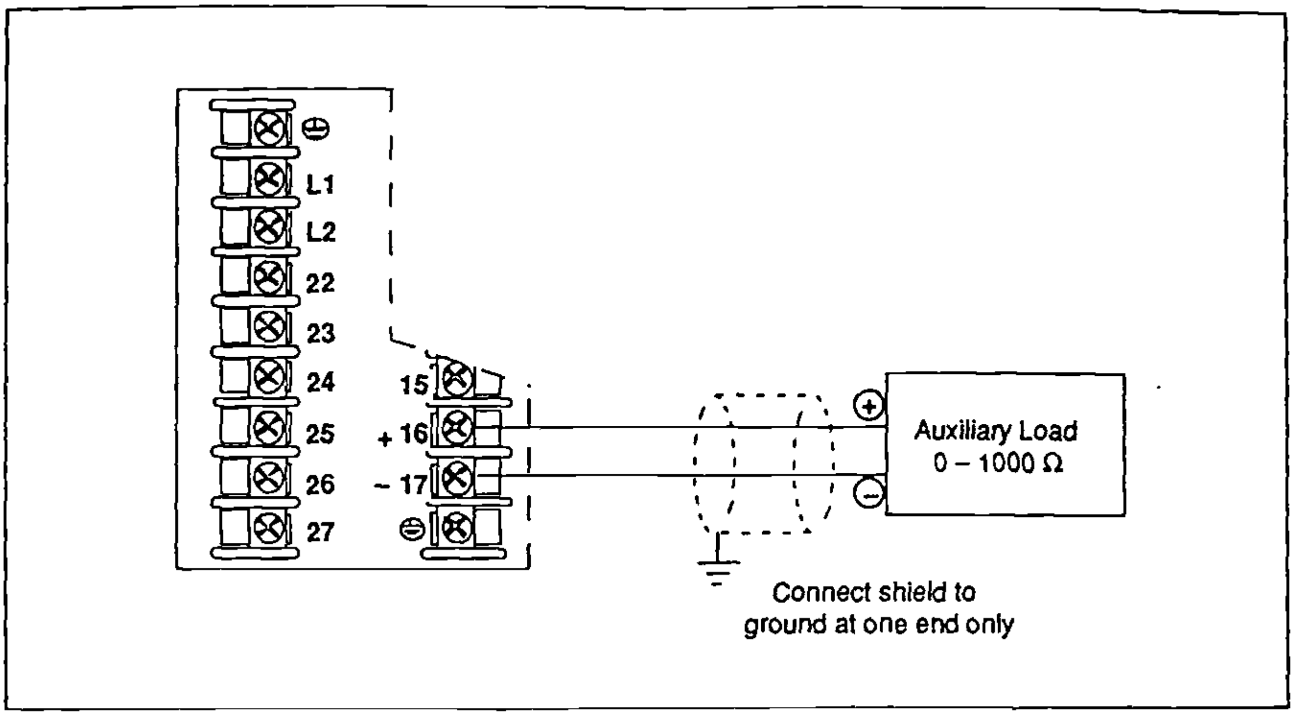
685 669

Auxiliary output connections

Figure 2-13 shows the wiring connections for the Auxiliary Output option.

Figure 2-13 Auxiliary Output Connections



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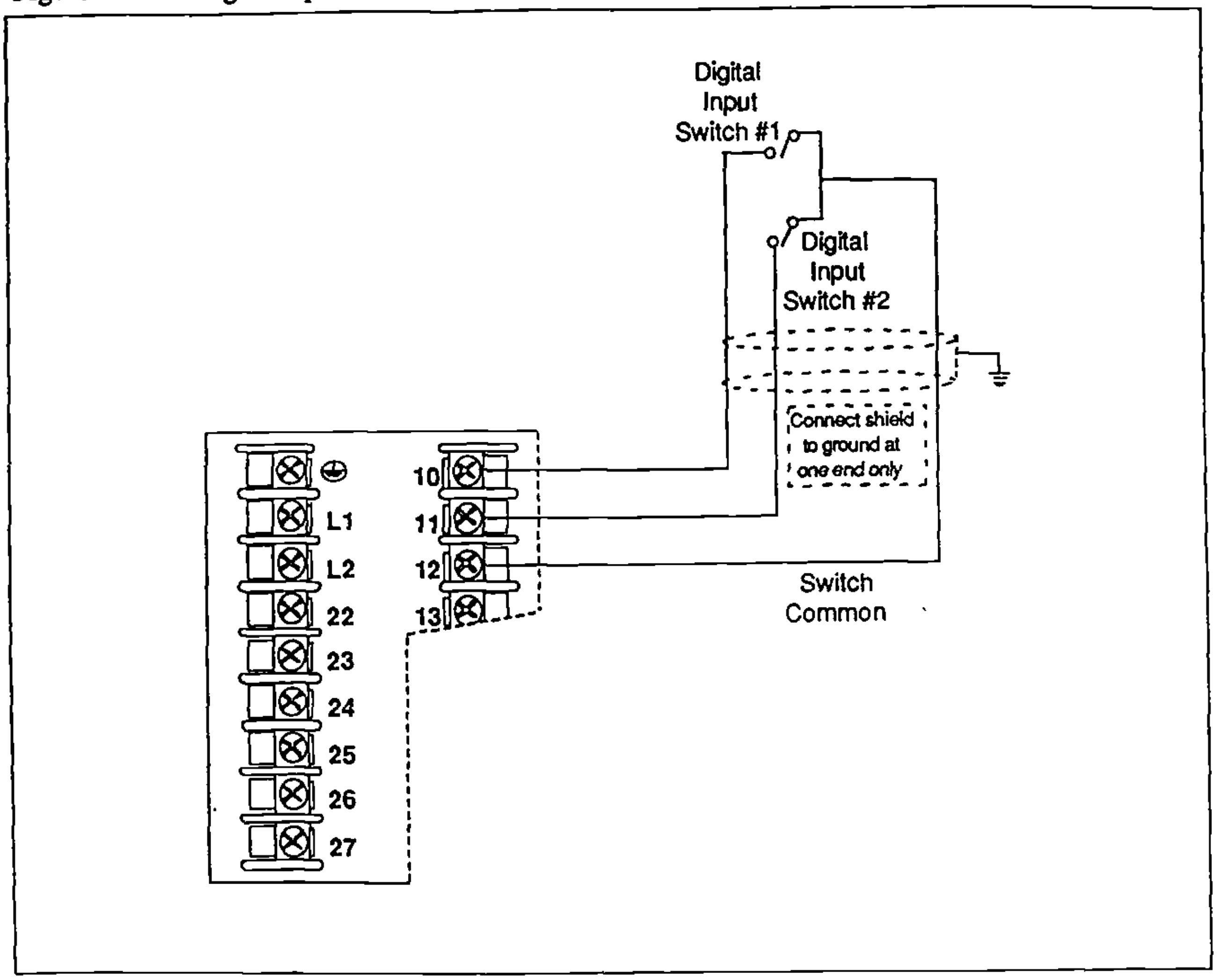
2.5 Wiring Diagrams, Continued

Digital Inputs connections

Figure 2-14 shows the wiring connections for the Digital Inputs option.

Figure 2-14 Digital Inputs Connections



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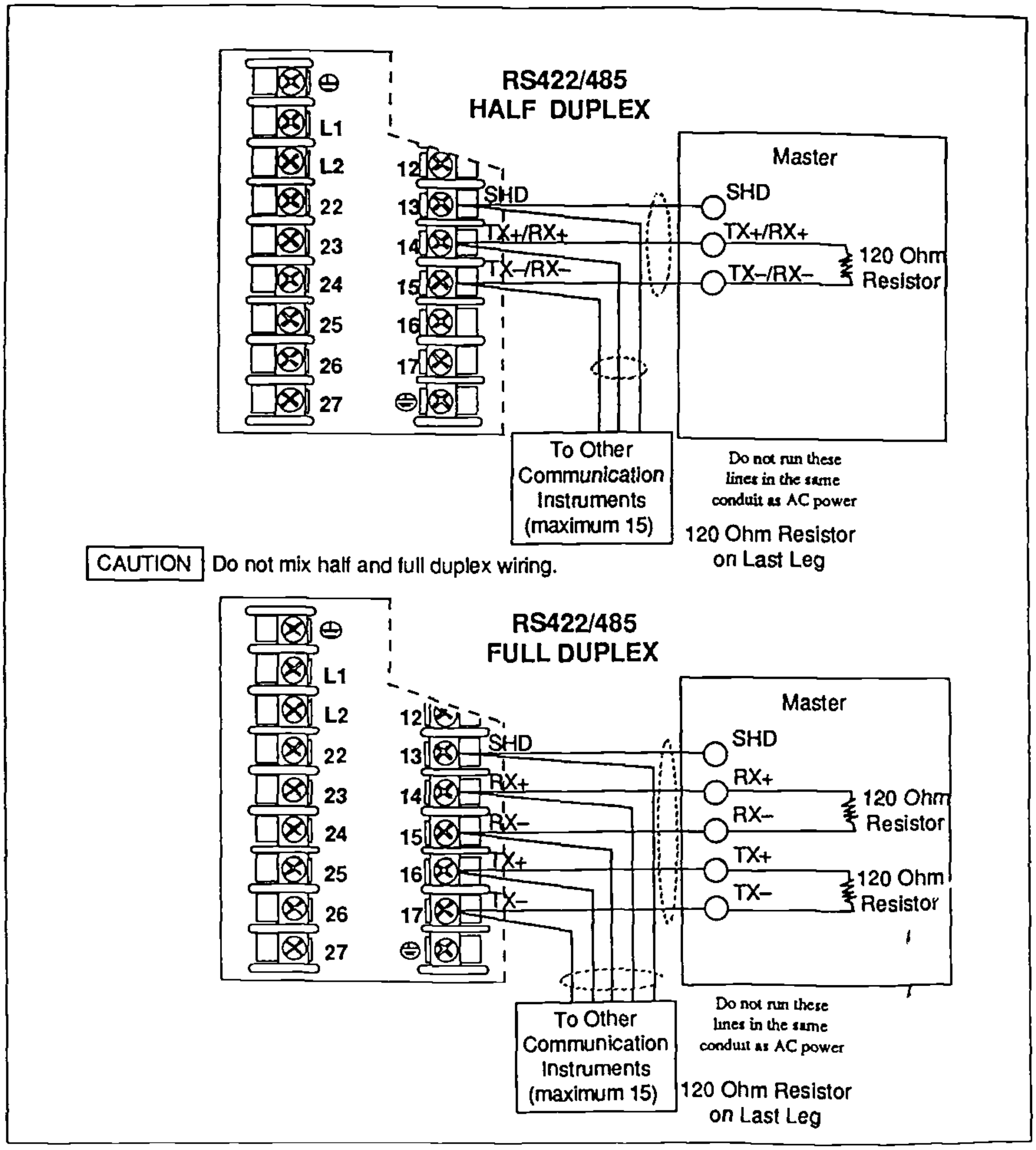
685 671

Communications option connections

There are two types of Communications option available:
- RS422/485 - Figure 2-15 (also refer to Document # 51-51-25-35)
- DMCS - Figure 2-16 (also refer to Document # 82-50-10-23)

Figure 2-15 RS422/485 Communications Option Connections



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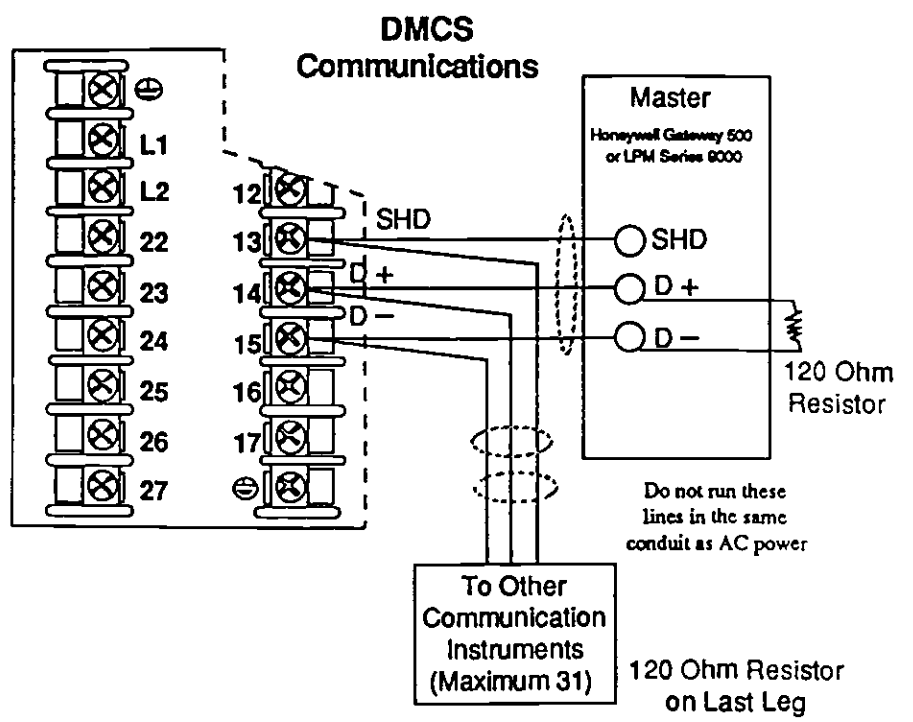
2.5 Wiring Diagrams, Continued

Communications option connections (continued)

Figure 2-16 shows the wiring connections for the DMCS Communications Option. (also refer to Document # 82-50-10-23)

Figure 2-16 DMCS Communications Option Connections



685 673

2.6 Control and Alarm Relay Contact Inf rmation

Control Relays

Table 2-3 lists the Control Relay Contact information.

ATTENTION Control relays operate in the standard control mode. i.e. Energized when output state is on.

Table 2-3 Control Relay Contact Information

Unit Power	Control Relay Wiring	Control Relay Contact	#1 or #2 Output Indicator Status
Off	N.O.	Open	Off
	N.C.	Closed	
On	N.O.	Open Closed	Off On
	N.C.	Closed Open	Off On

Alarm Relays

Table 2-4 lists the Alarm Relay Contact ınformation.

ATTENTION Alarm relays are designed to operate in a failsafe mode. i.e. De-energized during alarm state. This results in alarm actuation when power is OFF or when initially applied, until the unit completes self diagnostics. If power is lost to the unit, the alarms will function.

Table 2-4 Alarm Relay Contact Information

		Variable NOT in Alarm State		Variable in Alarm State	
Unit Power	Alarm Relay Wiring	Relay Contact	Indicators	Relay Contact	Indicators
Off	N.O	Open	Off	Open	Off
	N.C.	Closed		Closed	
On	N.O.	Closed	Off	Open	On
	N.C.	Open		Closed	

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685 675

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Section 3 – Configuration

3.1 Overview

Introduction

Configuration is a dedicated operation where you use straightforward keystroke sequences to select and establish (configure) pertinent control data best suited for your application.

What's in this section?

The table below lists the topics that are covered in this section.

Prompts

To assist you in the configuration process, there are prompts that appear in the upper and lower displays. These prompts let you know what group of configuration data (Set Up prompts) you are working with and also, the specific parameters (Function prompts) associated with each group.

Figure 3-1 shows you an overview of the prompt hierarchy.
As you will see, the configuration data is divided into 10 main Set Up groups plus prompts for calibration and prompts that show the status of the continuous background tests that are being performed.

Continued on next page

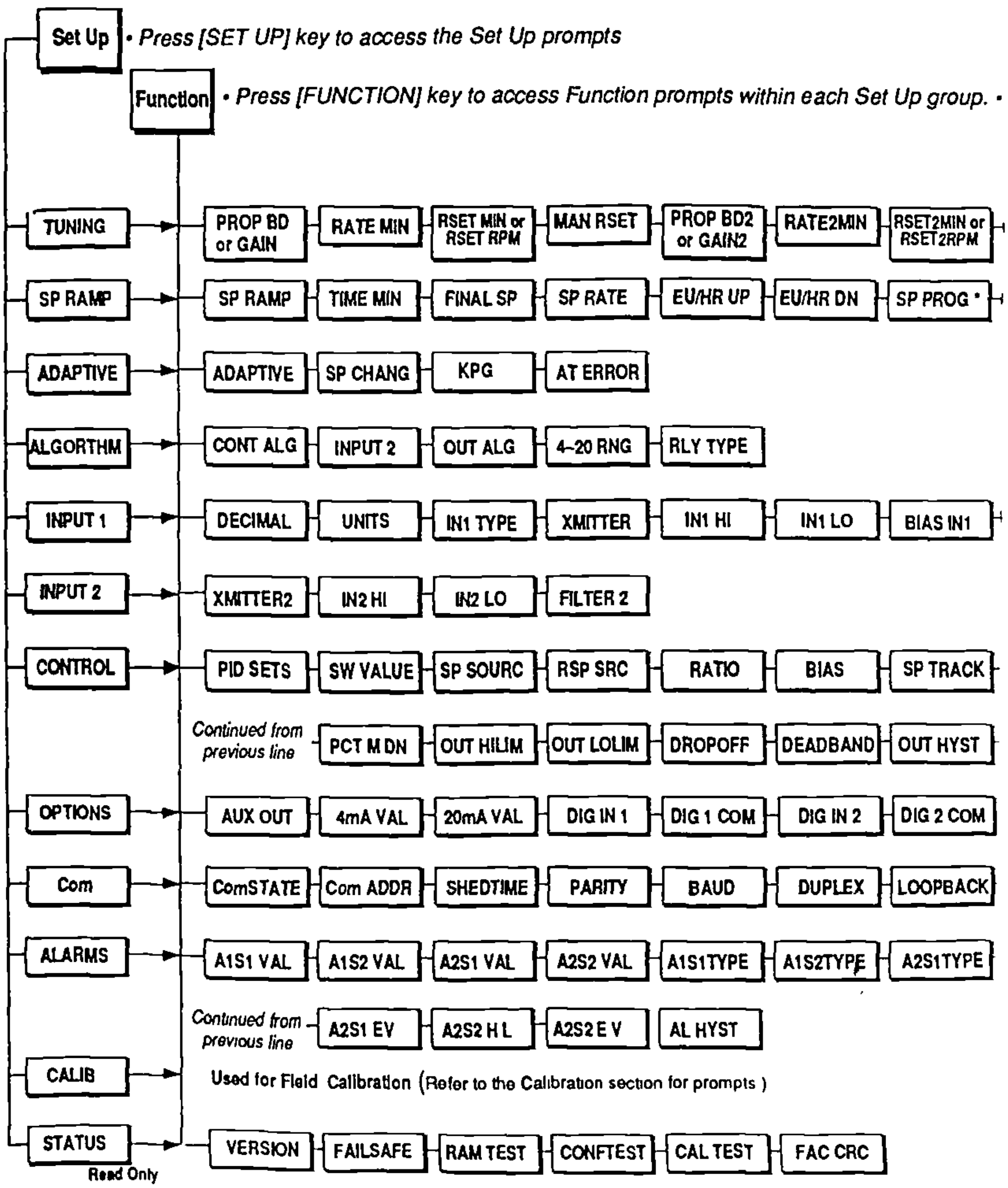
685 676

3.2 Configuration Prompts

Diagram: prompt hierarchy

Figure 3-1 shows an overview of the UDC3000 Set Up prompts and their associated Function prompts. - Read from left to right.

Figure 3-1 Overview of UDC3000 Prompt Hierarchy



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685 677

• • • *Press [▲] or [▼] to change the value or selection of the Function prompt.*

→ CYC SEC – CYC2SEC – SECURITY – LOCKOUT – AUTO MAN – SP SEL – RUN HOLD

→ Refer to the operation section for Setpoint programming prompts.

→ FILTER 1 – BURNOUT – EMISSIV – PWR FREQ – LANGUAGE

→ POWER UP – SP HILIM – SP LOLIM – ACTION – OUT RATE – PCT M UP – *Continued on next line*

→ FAILSAFE – MAN AUTO – AUTO OUT – PBor GAIN – MINor RPM

→ SHEDMODE – SHED SP – UNITS

→ A2S2TYPE – A1S1 H L – A1S1 EV – A1S2 H L – A1S2 EV – A2S1 H L – *Continued on next line*

3.3 How To Get Started

Read the configuration tips	Read "*Configuration Tips*" shown on the next page. These tips will help you to easily and quickly accomplish the tasks at which you will be working when you configure your controller.
Read configuration procedure	Read "*Configuration Procedure*". This procedure tells you how to access the Set Up groups, and the Function parameters within each of these grou that are shown in the Prompt Hierarchy in Figure 3-1.
Set Up groups	The Set Up groups and Function parameters are listed in the order of theii appearance. The list includes the name of the prompt, the range of setting selections available, and the factory setting.
Parameter explanations or definitions	If you need a detailed explanation of any prompt listed, refer to *Section 4 Configuration Parameter Definitions*. This section lists the Set Up and Function prompts, the selections or rang of settings that you can make for each, plus a detailed explanation or definition of each parameter
Configuration record sheet	Located on the last page of this section is a "*Configuration Record Sheet*" When you make your configuration selections, record them on this sheet. Then you will have a record of how the controller was configured.

685 679

3.4 Configuration Tips

Introduction

Listed below in Table 3-1 are a few tips that will help you enter the configuration data more quickly.

Table 3-1 Configuration Tips

Function	Tip
Displaying Groups	Use the [Set Up] key to display the Set Up groups. The group titles are listed in this section in the order that they appear in the controller.
Displaying Functions	Use the [Function] key to display the individual parameters under each group. The prompts are listed in the order of their appearance in each group.
Scrolling	To get to a Set Up group prompt more quickly, hold the [Set Up] key in. To get to a Function prompt more quickly, hold the [Function] key in. The display will scroll through the parameters. [ATTENTION] The prompting scrolls at a rate of 2/3 seconds when the [Set Up] or [Function] key is held in. Also, [▲] [▼] keys will move group prompts forward or backward at a rate twice as fast.
Changing values quickly	When Changing the value of a parameter, you can adjust a more significant digit in the upper display by holding in one key [▲] or [▼], and pressing the other [▲] or [▼] at the same time. The adjustment will move one digit to the left. Press the key again and you will move one more digit to the left.
Restoring to the original value	When you change the value or selection of a parameter while in Set Up mode and decide not to enter it, press [Run/Hold] once, the original value or selection will be recalled.
Exiting SET UP mode	To exit Set Up mode, press the [Lower Display] key. This returns the display to the same state it was in immediately preceding entry into the Set Up mode.
Timing out from Set Up mode	If you are in Set Up mode and do not press any keys for one minute, the controller will time out and revert to the mode and display that was being used prior to entry into Set Up mode.
Key Error	When a key is pressed and the prompt "KEY ERROR" appears in the lower display, it will be for one of the following reasons: • parameter not available • not in Set Up mode, press [SET UP] key first • key malfunction, do keyboard test (operation) • Individual key locked out

3.5 Configuration Procedure

Introduction

Each of the Set Up groups and their functions are pre-configured at the factory.
The factory settings are shown in the Set Up group tables that follow this procedure.
If you want to change any of these selections or values, follow the procedure in Table 3-2. This procedure tells you the keys to press to get to any Set Up group and any associated Function parameter prompt.
If you need a detailed explanation of any prompt, refer to *Section 4 – Configuration Parameter Definitions.*

Procedure

Follow the procedure listed in Table 3-2 to access the Set Up groups and Function prompts.

ATTENTION The prompting scrolls at a rate of 2/3 seconds when the [Set Up] or [Function] key is held in. Also, [▲] [▼] keys will move group prompts forward or backward at a rate twice as fast.

Table 3-2 Configuration Procedure

Step	Operation	Press	Result
1	Select Set Up mode	SET UP	Upper Display: SET UP — Lets you know you are in the configuration mode and a Set Up group title is being displayed in the lower display. Lower Display: TUNING — This is the first Set Up group title.
2	Select any Set Up group	SET UP	Successive presses of the [Set Up] key will sequentially display the other Set Up group titles shown in the prompt hierarchy in figure 3-1. You can also use the [▲] [▼] keys to scan the Set Up groups in both directions. Stop at the Set Up group title which describes the group of parameters you want to configure. Then proceed to the next step.
3	Select a Function Parameter	FUNCTION	Upper Display: 1.0 — Shows you the current value or selection for the first function prompt of the particular Set Up group that you have selected. Lower Display: GAIN — Shows the first Function prompt within that Set Up group. Example displays show Set Up group "Tuning", Function prompt "Gain" and the value selected.

Continued on next page

685 631

3.5 Configuration Procedure, Continued

Procedure (continued)

Table 3-2 Configuration Procedure, continued

Step	Operation	Press	Result
4	*Select other Function* Parameters	FUNCTION	*Successive* presses of the [Function] Key will sequentially display the other function prompts of the Set Up group you have selected. Stop at the function prompt that you want to change, then proceed to the next step.
5	Change the value or selection	▲ or ▼	These keys will increment or decrement the value or selection that appears for the function prompt you have selected. See "Configuration Tips" for instructions to increase or decrease value quickly. Change the value or selection to meet your needs. If the display flashes, you are trying to make an unacceptable entry.
6	Enter the value or selection	FUNCTION or SET UP	This key selects another function prompt. This key selects another Set Up group. The value or selection you have made will be entered into memory after another key is pressed.
7	Exit Configuration	LOWER DISPLAY	This exits configuration mode and returns the controller to the same state it was in immediately preceding entry into the Set Up mode. It stores any changes you have made.

3.6 Tuning Parameters Set Up Group

Introduction

The Tuning Set Up group contains the Function parameters that will allow your controller to respond correctly to changes in process variable or setpoint.

You can start with predetermined values but you will have to watch your process to determine how to modify them.

If you have the Adaptive Tune option, this will automatically select Gain, Rate, and Reset values.

Set this group last

Because this group contains functions that have to do with Security and Lockout, it is best to configure this group last, after all the other configuration data has been loaded.

Continued on next page

685 683

3.6 Tuning Parameters Set Up Group, Continued

Function prompts Table 3-3 lists all the function prompts in the Tuning Set Up group. How the "Algorithm" and "Control" Set Up groups are configured determines which prompts will appear.

Table 3-3 Tuning Group Function Prompts

Function Prompt (Lower Display)	Function Name	Selections or Range of Setting (Upper Display)	Factory Setting
PROP BD or GAIN	Proportional Band, or Gain	0.1 to 9999% 0.1 to 9999	1.0
RATE MIN	Rate in Minutes	0.08 to 10.00 minutes	0.00
RSET MIN	Reset in minutes/repeat	0.00 to 50.00	1.0
RSET RPM	Reset in repeats/minute	0.00 to 50.00	1.0
MAN RSET	Manual Reset	–100 to 100% Output	0.0
PROP BD2 or GAIN 2	Proportional Band 2, or Gain 2	0.1 to 9999% 0.1 to 9999	5.0
RATE2MIN	Rate 2 in Minutes	0.08 to 10.00 minutes	0.00
RSET2MIN	Reset 2 in minutes/repeat	0.00 to 50.00	0.2
RSET2RPM	Reset 2 in repeats/minute	0.00 to 50.00	0.2
CYC SEC	Cycle Time (Heat) Electromechanical Relays	1 to 120 seconds	20.0
CYC2 SEC	Cycle Time 2 (Cool) Electromechanical Relays	1 to 120 seconds	20.0
CYC SX3	Cycle Time(Heat) Solid State Relays	1 to 120 (1/3 second increments) 1 = .33 Sec. 120 = 40 Sec	20.0
CYC2SX3	Cycle Time(Cool) Solid State Relays	1 to 120 (1/3 second increments) 1 = .33 Sec. 120 = 40 Sec	20.0
SECURITY	Security Code	1 to 4095	
LOCKOUT	Configuration Lockout	NONE CALIB +CONF +VIEW MAX	CALIB
AUTO MAN	Manual/Auto Key Lockout	DISABLE ENABLE	ENAB
SP SEL	Setpoint Select Key Lockout	DISABLE ENABLE	ENAB
RUN HOLD	Run/Hold key Lockout	DISABLE ENABLE	ENAB

3.7 SP Ramp/Program Set Up Group

Single Setpoint Ramp

The Setpoint Ramp Set Up group contains the Function parameters that let you to configure a single set point ramp to occur between the current local setpoint and a final setpoint over a time interval (SP RAMP).

Setpoint rate

The Setpoint Ramp Set Up group also contains the function parameters that let you configure a specific rate of change for any Local Setpoint change (SP RATE). It includes selections for Rate Up and Rate Down.

Setpoint Program

Also included under this group are prompts for configuring a Setpoint program (SP PROG). The prompts and instructions for Setpoint programming are in the *Operation* section.

Function prompts

Table 3-4 lists all the function prompts in the SP RAMP Set Up group.

Table 3-4 SP Ramp Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
SP RAMP	Single Setpoint Ramp Selection	DISABLE ENABLE	DISABL
TIME MIN	Single Setpoint Ramp Time	0 to 255 minutes	3
FINAL SP	Single Setpoint Final Setpoint	Enter a value within the setpoint limits	
SP RATE	Setpoint Rate	DISABLE ENABLE	DISABL
EU/HR UP	Rate Up Value (SP Rate Enabled)	0 to 9999 in Units per Hour	
EU/HR DN	Rate Down Value (SP Rate Enabled)	0 to 9999 in Units per Hour	
SP PROG	Setpoint Programming	DISABLE ENABLE	DISABL

685 685

3.8 Adaptive Tune Set Up Group

Adaptive Tune

Adaptive Tune continuously adjusts the PID parameters in response to setpoint changes. You can select tuning on minimum setpoint changes of 5% up to 15% span. Perform adaptive tuning after you have configured the controller.
Adaptive Tune does not work with 3 Position Step Control algorithm.

Function prompts

Table 3-5 lists all the function prompts in the "ADAPTIVE" Set Up group.

Table 3-5 Adaptive Tune Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
ADAPTIVE *	Adaptive Tune	DISABLE SPoNLY	Disabl
SP CHANG	Setpoint Change	5 to 15% Input Span	10
KPG	Process Gain	0.01 to 50.00 (Normally Read Only)	1.0
AT ERROR	Adaptive Tune Error codes	Read Only NONE OUT LIM ID FAIL ABORT	

* ADAPTIVE TUNE DOES NOT WORK WITH 3 POSITION STEP CONTROL ALGORITHM

3.9 Alg rithm Data Set Up Group

Introduction

This data deals with various algorithms residing in the controller: Control Algorithm and Output algorithms, enabling the Second Input or the Current Duplex range, and selecting the type of relay.

Function prompts

Table 3-6 lists all the function prompts in the "ALGORITHM" Set Up group.

Table 3-6 Algorithm Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
CONT ALG	Control Algorithm	ON-OFF* PID A PID B PD+MR 3PSTEP*	PID A
INPUT 2	Input 2	ENABLE DISABLE	Disabl
OUT ALG**	Output Algorithm	TIME CURRNT POSITN TIME D CUR D CUR TI TI CUR	Depends on model
4–20RNG	Current Duplex Range (CUR D)	100PCT (FULL) 50 PCT (SPLIT)	50PCT
RLY TYPE*	Output Relay Type	MECHAN SOL ST	MECHAN

* For Time Proportional only. Prompt appears only if LOCKOUT=NONE
** Selections are model dependent. For example, current output models cannot be configured for Time Proportioning Simplex Output.

685 687

3.10 Input 1 Parameters Set Up Group

Introduction This data deals with various parameters required to configure Input 1.

Function prompts Table 3-7 lists all the function prompts in the "INPUT 1" Set Up group.

Table 3-7 Input 1 Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
DECIMAL	Decimal Point Location	XXXX None XXX.X One XX.XX Two	XXXX
UNITS	Temperature Units	DEG F DEG C NONE	NONE
IN1 TYPE	Input 1 Actuation Type	B TC T TC H E TC H T TC L E TC L W TC H J TC H W TC L J TC L 100 PT K TC H 100 LO K TC L 500 PT NNM TC H RADIAM NNM TC L 4-20mA NIC TC 0-10mV R TC 10-50m S TC 1-5 V 0-10V	0-10mV
XMITTER	Transmitter Characterization	B TC T TC H E TC H T TC L E TC L W TC H J TC H W TC L J TC L 100 PT K TC H 100 LO K TC L 500 PT NNM TC H RADIAM NNM TC L LINEAR NIC TC SQROOT R TC S TC	LINEAR
IN1 HI	Input 1 High Range Value (Linear Inputs only	–999.9 to 999. or –999 to 9999 in engineering units	1000
IN1 LO	Input 1 Low Range Value (Linear Inputs only)	–999.9 to 999. or –999 to 9999 in engineering units	0

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3.10 Input 1 Parameters Set Up Group, Continued

Function prompts, continued Table 3-7 lists all the function prompts in the "INPUT 1" Set Up group.

Table 3-7 Input 1 Group Function Prompts, continued

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
BIAS IN1	Input 1 Bias	–999.9 to 9999.	0
FILTER 1	Input 1 Filter	0 to 120 seconds	0
BURNOUT	Burnout Protection	NONE UP DOWN	NONE
EMISSIV	Emissivity	0.01 to 1.00	0
PWR FREQ	Power Line Frequency	60 Hz 50 Hz	60 Hz
LANGUAGE	Prompt Language	ENGLIS FRENCH GERMAN SPANIS ITALAN	ENGLIS

685 689

3.11 Input 2 Parameters Set Up Group

Introduction This data deals with various parameters required to configure Input 2. This only appears when input 2 in the "Algorithm" Group is enabled.

Function prompts Table 3-8 lists all the function prompts in the INPUT 2 Set Up group.

Table 3-8 Input 2 Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
XMITTER2	Transmitter Characterization	B TC E TC H E TC L J TC H J TC L K TC H K TC L NNM TC H NNM TC L NIC TC R TC S TC T TC H T TC L W TC H W TC L 100 PT 100 LO 500 PT RADIAM LINEAR SQROOT	LINEAR
IN2 HI	Input 2 High Range Value	–999.9 to 999. or –999 to 9999 in engineering units (Adjustable for linear inputs only)	1000
IN2 LO	Input 2 Low Range Value	–999.9 to 999. or –999 to 9999 in engineering units (Adjustable for linear inputs only)	0
FILTER 2	Input 2 Filter	0 to 120 seconds 0 = No Filter	0

3.12 Control Parameters S t Up Group

Introduction

This data deals with various parameters required to effectively control your process.

Function prompts

Table 3-9 lists all the function prompts in the "CONTROL" Set Up group.

Table 3-9 Control Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
PID SETS	Tuning Parameter Sets	1 ONLY 2KEYBD 2PV SW 2SP SW	1 ONLY
SW VALUE	Automatic Switchover Value	Value in Engineering Units	0.00
SP SOURC	Local Setpoint Source	1 LOCAL 2 LOCAL	1 LOCAL
RSP SRC	Remote Setpoint Source	NONE IN2	NONE
RATIO	Ratio	–20.00 to 20.00	1.0
BIAS	Bias	–9999 to 9999 in engineering units	0
SP TRACK	Local Setpoint Tracking	NONE PV RSP	NONE
POWER UP	Power Up Recall	MANUAL A LSP A RSP AM SP AM LSP	MANUAL
SP HILIM	Setpoint High Limit	0 to 100% of span input in engineering units with decimal place.	1000
SP LOLIM	Setpoint Low Limit	0 to 100% of span input in engineering units with decimal place.	1000
ACTION	Control Output Direction	DIRECT REVERSE	REVERSE
OUT RATE	Output Change Rate	ENABLE DISABLE	DISABL

Table continued on next page

685 601

3.12 Control Parameters Set Up Group, Continued

Function prompts, continued Table 3-9 lists all the function prompts in the "CONTROL" Set Up group.

Table 3-9 Control Group Function Prompts, continued

Function Prompt (Lower Display)	Function Name	Selections or Range of Setting (Upper Display)	Factory Setting
PCT/M UP	Output Rate Up Value	0 to 9999% / minute	0
PCT/M DN	Output Rate Down Value	0 to 9999% / minute	0
OUTHILIM	High Output Limit	–5.0 to 105.0% of output	100.0
OUTLOLIM	Low Output Limit	–5.0 to 105.0% of output	0
DROPOFF	Controller Dropoff Value	–5.0 to 105.0% of output	0.0
DEADBAND	Output Relay Deadband	*Time Proportional Duplex:* –5.0 to 25.0% *On-Off Duplex:* 0.0 to 25.0% *Position Proportional or Three Position Step:* 0.5 to 5.0%	2.0
OUT HYST	Output Relay Hysteresis	0.0 to 5.0%	0.5
FAILSAFE	Failsafe Output Value	Set within the range of the output limits.	0.0
MAN OUT	Power-up Manual Mode Output Preset Value	0.0 to 100.0%	0.0
AUTO OUT	Power-up Automatic Mode Output Preset Value	0.0 to 100.0%	0.0
PBorGAIN	Proportional Band or Gain Units	PB PCT GAIN	GAIN
MINorRPM	Reset Units	RPM MIN	MIN

3.13 Options Set Up Group

Introduction

This data deals with various options that are available with your controller. If your controller does not have any of these options the prompts will not appear.

Function prompts

Table 3-10 lists all the function prompts in the "Options" Set Up group.

Table 3-10 Options Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
AUX OUT	Auxiliary Output Representation	DISABL IN 1 IN 2 PV DEV OUTPUT SP	DISABL
4mA VAL	Auxiliary Output Low Scaling Factor	Low scale value to represent 4 mA. Value in % for output. All other in Engineering units.	0
20mA VAL	Auxiliary Output High Scaling Factor	High scale value to represent 20 mA. Value in % for output. All other in Engineering units.	0
DIG IN 1	Digital Input 1 selections	NONE To MAN To LSP To 2SP To DIR To HOLD ToPID2 PV 2IN To RUN To BEGN STOP I MAN FS To LOCK To A OUT	NONE
DIG1 COM	Digital Input 1 Combinations	DISABL +PID2 +TO DIR +TO SP2 +DISAT	DISABL
DIG IN 2	Digital Input 2 selections	Same as DIG IN 1	NONE
DIG 2 COM	Digital Input 2 Combinations	Same as DIG1 COM	DISABL

685 693

3.14 Communications Group

Introduction

This data deals with the Communications option that is available with your controller. This option allows the controller to be connected to a host computer via a RS422 or DMCS bus.

If your controller does not have this option the prompts will not appear.

Function prompts

Table 3-11 lists all the function prompts in the "Com" Set Up group.

Table 3-11 Com Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
ComSTATE	Communications Option State	DISABL DMCS RS422	DISABL
Com ADDR	Communications Station Address	1 to 99	0
SHEDTIME	Shed Time	1 to 255 sample periods	0
PARITY (RS422 Only)	Parity	ODD EVEN	ODD
BAUD (RS422 Only)	Baud Rate	300 4800 600 9600 1200 19200 2400	300
DUPLEX (RS422 Only)	Duplex Operation	HALF FULL	
LOOPBACK	Local Loop Back	DISABL ENABLE	DISABL
SHEDMODE (DMCS Only)	Shed Controller Mode and Output Level	LAST TO MAN FSAFE ToAUTO	LAST
SHED SP (DMCS Only)	Shed Setpoint Recall	TO LSP TO CSP	TO LSP
UNITS	Communication Units	PERCNT ENG	PERCNT

3.15 Alarms Set Up Group

Introduction

This data deals with the Alarms function that is available with your controller.

There are two alarms available. Each alarm has two setpoints.

You can configure each of these two setpoints to alarm on one of nine events and you can configure each setpoint to alarm High or Low.

You can also configure the two setpoints to alarm on the same event and to alarm both high and low, if desired.

Function prompts

Table 3-12 lists all the function prompts in the "Alarms" Set Up group.

Table 3-12 Alarms Group Function Prompts

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
A1S1 VAL	Alarm 1, Setpoint 1 Value	Value in Engineering Units	90
A1S2 VAL	Alarm 1, Setpoint 2 Value	Value in Engineering Units	10
A2S1 VAL	Alarm 2, Setpoint 1 Value	Value in Engineering Units	95
A2S2 VAL	Alarm 2, Setpoint 2 Value	Value in Engineering Units	5
A1S1TYPE	Alarm 1, Setpoint 1 Type	NONE IN 1 (Input 1) IN 2 (Input 2) PV (Process Variable) DEV (Deviation) OUTPUT SHED (Communications) EVON(SP Programming) EVOFF(SP Programming)	NONE
A1S2TYPE	Alarm 1, Setpoint 2 Type	Same as A1S1TYPE	NONE
A2S1TYPE	Alarm 2, Setpoint 1 Type	Same as A1S1TYPE	NONE
A2S2TYPE	Alarm 2, Setpoint 2 Type	Same as A1S1TYPE	NONE
A1S1 H L	Alarm 1, Setpoint 1 State	LO HI	HI
A1S1 EV	SP Programming Event Alarm State for Alarm 1, Setpoint 1	BEGIN END	

Table continued on next page

685 695

3.15 Alarms Set Up Group, Continued

Function prompts, continued

Table 3-12 lists all the function prompts in the "Alarms" Set Up group.

Table 3-12 Alarms Group Function Prompts, continued

Function Prompt Lower Display	Function Name	Selections or Range of Setting Upper Display	Factory Setting
A1S2 H L	Alarm 1, Setpoint 2 State	LO HI	LO
A1S2 EV	SP Programming Event Alarm State for Alarm 1, Setpoint 2	BEGIN END	
A2S1 H L	Alarm 2, Setpoint 1 State	LO HI	HI
A2S1 EV	SP Programming Event Alarm State for Alarm 2, Setpoint 1	BEGIN END	
A2S2 H L	Alarm 2, Setpoint 2 State	LO HI	LO
A2S2 EV	SP Programming Event Alarm State for Alarm 2, Setpoint 2	BEGIN END	
AL HYST	Alarm Hysteresis	0.0 to 5.0 % of Output or Span as appropriate	0.1

685 696

3.16 Calib Group

Calibration data

The prompts used here are for field calibration purposes.
Refer to *Section 7 – Calibration* in this manual for complete information and instructions.

3.17 Status Group

Status Test Data

The prompts used here are read only.
They are used to determine the reason for a controller failure.
Refer to *Section 9 – Troubleshooting* in this manual for complete information.

685 697

3.18 Configuration Record Sheet

Keep a record Enter the value or selection for each prompt on this sheet so you will have a record of how your controller was configured.

Group Prompt	Function Prompt	Value or Selection	Factory Setting
TUNING	PROP BD		1.0
	or		
	GAIN		1.0
	RATE MIN		0.00
	RSET MIN		1.0
	or		
	RSET RPM		1.0
	or		
	MAN RSET		0.0
	PROP BD2		1.0
	or		
	GAIN 2		1.0
	RATE2MIN		0.00
	RSET2MIN		1.0
	or		
	RSET2RPM		1.0
	CYCSEC		20.0
	CYC2SEC		20.0
	SECURITY		0
	LOCKOUT		CALIB
	AUTO MAN		ENAB
	SP SEL		ENAB
	RUN HOLD		ENAB
SP RAMP	SP RAMP		DISABL
	TIME MIN		3
	FINAL SP		—
	SP RATE		DISABL
	EU/HR UP		—
	EU/HR DN		—
	SP PROG		DISABL
ADAPTIVE	ADAPTIVE		DISABL
	SP CHANG		10
	KPG		1.0
ALGORITHM	CONT ALG		PID A
	INPUT 2		DISABL
	OUT ALG		—
	4–20RNG		50PCT
	RLY TYPE		MECHAN
INPUT 1	DECIMAL		XXXX
	UNITS		NONE
	IN1 TYPE		0—10mV
	XMITTER		LINEAR
	IN1 HI		1000
	IN1 LO		0
	BIAS IN1		0
	FILTER 1		1
	BURNOUT		NONE
	EMISSIV		0
	PWR FREQ		60HZ
	LANGUAGE		ENGLIS
INPUT 2	XMITTER 2		LINEAR
	IN2 HI		1000
	IN2 LO		0
	FILTER 2		1

Group Prompt	Function Prompt	Value or Selection	Factory Setting
CONTROL	PID SETS		1 ONLY
	SW VALUE		0.00
	SP SOURC		1 LOCAL
	RSP SRC		NONE
	RATIO		1.0
	BIAS		0
	SP TRACK		NONE
	POWER UP		MANUAL
	SP HILIM		1000
	SP LOLIM		0
	ACTION		REVERSE
	OUT RATE		DISABL
	PCT/M UP		0
	PCT/M DN		0
	OUT HILIM		100.0
	OUT LOLIM		0
	DROPOFF		0.0
	DEADBAND		2.0
	OUT HYST		0.5
	FAILSAFE		0.0
	MAN OUT		0.0
	AUTO OUT		0.0
	PBorGAIN		GAIN
	MINorRPM		MIN
OPTIONS	AUX OUT		DISABL
	4mA VAL		0
	20mA VAL		0
	DIG IN 1		NONE
	DIG IN 2		NONE
Com	ComSTATE		DISABL
	Com ADDR		0
	SHEDTIME		0
	PARITY		ODD
	BAUD		300
	DUPLEX		—
	LOOPBACK		DISABL
	SHEDMODE		LAST
	SHED SP		TO LSP
	UNITS		PERCNT
ALARMS	A1S1 VAL		90
	A1S2 VAL		10
	A2S1 VAL		95
	A2S2 VAL		5
	A1S1TYPE		NONE
	A1S2TYPE		NONE
	A2S1TYPE		NONE
	A2S2TYPE		NONE
	A1S1 H L		HI
	A1S1 EV		—
	A1S2 H L		LO
	A1S2 EV		—
	A2S1 H L		HI
	A2S1 EV		—
	A2S2 H L		LO
	A2S2 EV		—
	AL HYST		0.1

685 698

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685 699

Section 4 – Configuration Prompt Definitions

4.1 Overview

Introduction

This section provides information for all the user configurable parameters listed in the configuration section. If you aren't familiar with these parameters, this section gives you the parameter prompt, the selection or range of setting that you can make, and a definition of how each parameter setting affects controller performance. It will also refer you to any other prompts that might be affected by your selection.

What's in this section?

The table below lists the topics that are covered in this section. They are listed in the order of their appearance in the controller.

4.2 Tuning Parameters Set Up Group

Introduction

Tuning consists of establishing the appropriate values for the tuning constants you are using so that your controller responds correctly to changes in process variable and setpoint. You can start with pre-determined values but you will have to watch the system to see how to modify them. Adaptive Tune feature automatically selects Gain, Rate, and Reset.

Set this group last

Because this group contains functions that have to do with security and lockout, we recommend that you configure this group last, after all the other configuration data has been loaded.

Tuning group prompts

Table 4-1 lists all the function prompts in the Tuning setup group and their definitions.

Table 4-1 Tuning Group Prompt Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
PROP BD or GAIN	0.1 to 999.9% or 0.1 to 9999	**PROPORTIONAL BAND** is the percent of the range of the measured variable for which a proportional controller will produce a 100% change in its output. **GAIN** is the ratio of output change (%) over the measured variable change (%) that caused it. $G = \frac{100\%}{PB\%}$ where PB is the proportional band (in %) If the PB is 20%, then the Gain is 5. Likewise, a 3% change in the error signal (SP-PV) will result in a 15% change in the controller's output due to proportional action. If the Gain is 2, then the PB is 50%. Defined as "HEAT" Gain on Duplex models for variations of Heat/Cool applications. The selection of Prop. Band or Gain is made in the control parameter group under prompt "PBorGAIN."
RATE MIN	0.08 to 10.00 minutes 0.08 or less = OFF	**RATE** action affects the controller's output whenever the deviation is changing; and affects it more when the deviation is changing faster. Defined as "HEAT" Rate on Duplex models for variations of Heat/Cool applications.

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4.2 Tuning Parameters Set Up Group, Continued

Table 4-1 Tuning Group Prompt Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
RSET MIN or RSET RPM	0.00 to 50.00	RSET MIN = RESET IN MINUTES / REPEAT RSET RPM = RESET IN REPEATS PER MINUTE RESET adjusts the controller's output in accordance with both the size of the deviation (SP-PV) and the time it lasts. The amount of the corrective action depends on the value of Gain. The Reset adjustment is measured as how many times proportional action is repeated/minute. Used with control algorithm PID-A or PID-B. Defined as "HEAT" Reset on Duplex models for variations of Heat/Cool applications. The selection of minutes per repeat or repeats per minute is made in the control parameters group under prompt "MINorRPM."
MAN RSET	−100 to +100 (in % output)	MANUAL RESET is only applicable if you have control algorithm PD WITH MANUAL RESET. Because a proportional controller will not necessarily line out at setpoint, there will be a deviation (offset) from setpoint. This eliminates the offset and lets the PV line out at setpoint.
PROP BD2 or GAIN 2	0.1 to 999.9% or 0.1 to 999.9	PROPORTIONAL BAND 2 or GAIN 2, RATE 2, and RESET 2 parameters are the same as previously described for "Heat" except that they refer to the cool zone tuning constants on duplex models or the second set of PID constants, whichever is pertinent.
RATE2MIN	0.08 to 10.00 minutes 0.08 or less = OFF	
RSET2MIN RSET2RPM	0.02 to 50.00	
CYC SEC	1 to 120 seconds	CYCLE TIME (HEAT) determines the length of one time proportional output relay cycle. Defined as "HEAT" cycle time for Heat/Cool applications. Electromechanical relays
CYC2 SEC	1 to 120 seconds	CYCLE TIME 2 (COOL) is the same as above except it applies to Duplex models as the cycle time in the "COOL" zone of Heat/Cool applications or for 2nd set of PID constants. Electromechanical relays
CYC SX3	1 to 120 (1/3 second increments) 1 = .33 sec./120 = 40 sec.	CYCLE TIME (HEAT) - same as above except for solid state relays. Algorithm prompt "RLY TYPE", selection "SOL ST"
CYC2 SX3	1 to 120 (1/3 second increments) 1 = .33 sec./120 = 40 sec	CYCLE TIME 2 (COOL) same as above except for solid state relays. Algorithm prompt "RLY TYPE", selection "SOL ST"

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4.2 Tuning Parameters Set Up Group, Continued

Table 4-1 Tuning Group Prompt Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
SECURITY	0001-4095	**SECURITY CODE** – The level of keyboard lockout may be changed in the set up mode. Knowledge of a security code may be required to change from one level to another. Select this number here, copy it, and keep it in a secure location. Entering "0" disables the security code feature. NOTE: The Security Code is for keyboard entry only and is not available via communications. Can only be changed if "LOCKOUT" selection is "NONE".
LOCKOUT		**LOCKOUT** applies to one of the functional groups: Configuration, Calibration, Tuning, Adaptive Tune. **DO NOT CONFIGURE UNTIL ALL CONFIGURATION IS COMPLETE.**
	NONE	No Lockout – all groups read/write. Allows individual key lockout.
	CALIB	**CALIB** – All are available for read/write except for the Calibration and Keyboard Lockout groups.
	+CONF	**+CONF** – Tuning, SP Ramp, and Adaptive Tune groups are read/write. All other groups are read only. Keyboard Lockout and Calibration groups are not available.
	+VIEW	**+VIEW** – Tuning and Setpoint Ramp parameters are read/write. No other parameters are viewable.
	MAX	**MAX** – Tuning and Setpoint Ramp parameters are available for read only. No other parameters are viewable
AUTO MAN		**MANUAL/AUTO KEY LOCKOUT** – Allows you to disable the Manual/Auto key.
	DISABL ENABLE	Disable Enable Can only be viewed if "LOCKOUT" is configured for "NONE".
SP SEL		**SETPOINT SELECT KEY LOCKOUT** – Allows you to disable the Setpoint Select key.
	DISABL ENABLE	Disable Enable Can only be viewed if "LOCKOUT" is configured for "NONE".
RUN HOLD		**RUN/HOLD KEY LOCKOUT** – Allows you to disable the Run/Hold key.
	DISABL ENABLE	Disable Enable Can only be viewed if "LOCKOUT" is configured for "NONE".

685 703

4.3 Setpoint Ramp/Program Set Up Group

Introduction

A single setpoint ramp can be configured to occur between the current local setpoint and a final local setpoint over a time interval of from 1 to 255 minutes.
There is also a configurable rate of change for any local setpoint change.
You can also configure a 12 segment program from a Ramp/Soak profile.
You can start and stop the ramp/program using the RUN/HOLD key.

Setpoint Ramp/Rate/Program group prompts

Table 4-2 lists all the function prompts in the Setpoint Ramp/Rate/Program setup group and their definitions.

Table 4-2 Setpoint Ramp/Rate/Program Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
SP RAMP		SINGLE SETPOINT RAMP — Make selection to enable or disable the setpoint ramp function. Make sure you configure a ramp time and a final setpoint value. "SP RATE" and "SP PROG" must be disabled.
	ENABLE	ENABLE SETPOINT RAMP — Allows you to start the setpoint ramp (in automatic mode).
	DISABL	DISABLE SETPOINT RAMP — Disables the setpoint ramp.
TIME MIN	0 to 255 minutes	SETPOINT RAMP TIME — Enter the number of minutes desired to reach the final setpoint. A ramp time of "0" implies and immediate change of setpoint.
FINAL SP	Within SP limits	SETPOINT RAMP FINAL SETPOINT — Enter the value desired for the final setpoint. The controller will operate at the setpoint set here when ramp is ended.
SP RATE		SETPOINT RATE — Lets you configure a specific rate of change for any local setpoint change. "SP RAMP" and "SP PROG" must be disabled.
	ENABLE	ENABLE SETPOINT RATE — allows the SP rate feature
	DISABL	DISABLE SETPOINT RATE — disables the setpoint rate
EU/HR UP	0 to 9999 in Engineering Units per hour	RATE UP — Value for SP Rate selection
EU/HR DN	0 to 9999 in Engineering Units per hour	RATE DOWN — Value for SP Rate selection
SP PROG (option)		SETPOINT RAMP/SOAK PROGRAM Available only with controllers that contain this option.
	ENABLE	For reasons of convenience, the information for the prompts when SP PROG is enabled are included in *Section 6 — Setpoint Programming Option.*
	DISABL	"SP RAMP" and "SP RATE" must be disabled.

4.4 Adaptive Tune Set Up Group

Introduction

Adaptive Tune continuously adjusts the PID parameters in response to setpoint changes. Also, it can be used during start-up without prior initialization or process knowledge.

Adaptive Tune group prompts

Table 4-3 lists all the function prompts in the Adaptive Tune setup group and their definitions.

Table 4-3 Adaptive Tune Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
ADAPTIVE		**ADAPTIVE TUNE**
	DISABL	**DISABLE ADAPTIVE TUNE** – Disables the Adaptiv Tune function.
	SPoNLY	**SETPOINT ONLY** – This selection tunes on setpoin changes only. It employs time domain analysis to accelerate line out at any desired setpoint without prior initialization or process knowledge. SP Only is the recommended start-up mode - to be used when no knowledge of the process tuning values is available. In the Start-up mode, and after enabling ADAPTIVE, the operator simply lines out the process variable in manual mode, selects the desired SP value and switches to automatic mode.
SP CHANG	5 to 15%	**SETPOINT CHANGE** - The minimum setpoint change that will result in re-tuning must be configured between 5% and 15%: i.e. If the range is 0 to 2400 and 5% is configured, re-tuning will occur if the setpoint change is 120 or larger.
KPG	0.01 to 50.00	**PROCESS GAIN** – This is the Gain of the process being tuned. It is automatically calculated during tuning process. This is normally a READ only value. It should only need to be changed if the controller fails to identify the process. In this case, set the value to algebraic value of PV in percent, divided by output in percent while in the manual mode. **ATTENTION** Note you must disable Adaptive tune to change tuning constant values from the keyboard.

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685 705

4.4 Adaptive Tune Set Up Group, Continued

Table 4-3 Adaptive Tune Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
AT ERROR		**ADAPTIVE TUNE ERROR STATUS** – When an error is detected in the Adaptive Tune process, an error prompt will appear.
	NONE	**NO ERRORS**
	OUTLIM	**OUTPUT GREATER OR LESS THAN OUTPUT LIMITS** – Output set insufficiently to get Setpoint value.
	IDFAIL	**IDENTIFICATION PROCESS FAILED** – An illegal value for Gain, Rate, or Reset was calculated.
	ABORT	**CURRENT ADAPTIVE TUNE PROCESS ABORTED** – caused by one of the following conditions: • changing to manual mode • digital input detected • In heat region of output and a cool output calculated or vice versa.

4.5 Algorithm Data Set Up Group

Introduction This data deals with various algorithms in the controller: Control algorithm, Output algorithm, Enabling the second input, or the Current Duplex range.

Algorithm group prompts Table 4-4 lists all the function prompts in the Algorithm setup group and their definitions.

Table 4-4 Algorithm Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
CONT ALG		The **CONTROL ALGORITHM** lets you select the type of control that is best for your process.
	ON-OFF	**ON/OFF** is the simplest control type. The output can be either ON (100%) or OFF (0%). The Process Variable (PV) is compared with the setpoint (SP) to determine the sign of the error (ERROR = PV-SP). The ON/OFF algorithm operates on the sign of the error signal. In Direct Acting Control, when the error signal is positive, the output is 100%; and when the error signal is negative, the output is 0%. If the control action is reverse, the opposite is true. An adjustable overlap (Hysteresis Band) is provided between the on and off states. Other prompts affected: "OUT HYST" **DUPLEX ON/OFF** is an extension of this algorithm when the output is configured for Duplex. It allows the operation of a second ON/OFF output. There is a deadband between the operating ranges of the two inputs and an adjustable overlap (hysteresis) of the on and off states of each output. Both Deadband and Hysteresis are separately adjustable. With no relay action the controller will read 50%. Other prompts affected: "OUT HYST" and "DEADBAND"
	PID A NOTE: PID A should not be used for Proportional only action. i.e. no integral (reset) action. Instead, use PD+MR with rate set to 0.	**PID A** is normally used for three-mode control. This means that the output can be adjusted somewhere between 100% and 0%. It applies all three control actions — Proportional (P), Integral (I), and Derivative (D) — to the error signal. Proportional (Gain) — regulates the controller's output in proportion to the error signal (the difference between Process Variable and Setpoint). Integral (Reset) -- regulates the controller's output to the size of the error and the time the error has existed. (The amount of corrective action depends on the value of proportional Gain.) Derivative (Rate) -- regulates the controller's output in proportion to the rate of change of the error. (The amount of corrective action depends on the value of proportional Gain.)

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685 707

4.5 Algorithm Data Set Up Group, Continued

Table 4-4 Algorithm Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
CONT ALG continued	PID B	**PID B** Unlike the PID-A equation, the controller gives only an integral response to a setpoint change, with *no effect* on *the output due to* the gain or rate action, and it gives full response to PV changes. Otherwise controller action is as described for the PID-A equation. See note on PID-A.
	PD+MR	**PD WITH MANUAL RESET** is used whenever integral action is not wanted for automatic control. The equation is computed with no integral contribution. The MANUAL RESET, which is operator adjustable, is then added to the present output to form the controller output. Switching between manual and automatic mode will not be bumpless. If you select PD with Manual Reset you can also configure the following variations • PD (Two Mode) control, • P (Single Mode) control. Set Rate(D) and/or Reset Time(I) to 0. Other prompts affected: "MAN RSET"
	3PSTEP	The **THREE POSITION STEP** algorithm allows the control of a valve (or other actuator), with an electric motor driven by two controller relay outputs; one to move the motor upscale, the other downscale without a feedback slidewire linked to the motor shaft. The deadband and hysteresis are adjustable in the same manner as the duplex output algorithm. The Three Position Step Control algorithm provides an output display (OUT) which is an estimated motor position since the motor is not using any feedback. Although this output indication is only an approximation, it is "corrected " each time the controller drives the motor to one of its stops (0% or 100%). It avoids all the control problems associated with the feedback slidewire (wear, dirt, noise). When operating in this algorithm, the estimated "OUT" display is shown to the nearest percent (i.e. no decimal). Refer to the Operation section for motor position displays. As a customer configurable option, when a second input board is installed, the motor slidewire can be connected to the controller. The actual slidewire position is then shown on the lower display as "POS". **This value is used for display only, it is not used in the 3 Position Step algorithm.** To configure this option, set the Input 2 Enable/Disable prompt shown next to "DISABLE". Calibrate the slidewire. Other prompts affected: "DEADBAND"

Continued on next page

4.5 Algorithm Data Set Up Gr up, Continued

Table 4-4 Algorithm Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
INPUT 2	ENABLE DISABLE	**INPUT 2** algorithm allows you to enable or disable the second input. Appears only when input 2 is ordered.
OUT ALG		The **OUTPUT ALGORITHM** lets you select the type of output you want. Not applicable with Control Algorithm prompt "3PSTEP." *Selections are model dependent. For example, current output models cannot be configured for Time Proportioning Simplex Output.*
	TIME	**RELAY SIMPLEX** — Type of output using one SPDT relay. Its normally open (NO) or normally closed (NC) contacts are selected when wiring the rear terminals. Other prompts affected: "OUT HYST"
	CURRNT	**CURRENT SIMPLEX** — Type of output using one 2 to 20 mA signal that can be fed into a positive or negative grounded load of 0 to 1000 ohms. The signal can be recalibrated for any desired range from 2 to 20 mA for 0 to 100% output.
	POSITN	**POSITION PROPORTIONAL SIMPLEX** — Type of output using two SPDT relays and a motor which has a 100 to 1000 ohms feedback slidewire. Other prompt affected: "DEADBAND"
	TIME D	**RELAY DUPLEX** — Type of output using two SPDT relays. Its normally open (NO) or normally closed (NC) contacts are selected when wiring the rear terminals (see Installation section). Other prompts affected: "DEADBAND"
	CUR D	**CURRENT DUPLEX** is similar to current simplex but provides a second current output if Auxiliary output is used. The second output is usually scaled so that zero and span correspond with 0% and 50% output (cool zone). When the output is 0 to 50%, the controller uses tuning parameter set #2, when the output is 50 to 100% it uses set #1. NOTE: Auxiliary Output must be configured for "OUTPUT." Other prompts affected: "DEADBAND", "4-20RNG".
	CUR TI	**CURRENT/RELAY DUPLEX (RELAY = HEAT)** is a variation of duplex with current active for 0 to 50% output (tuning set 2) and relay#1 is active 50 to 100% output (tuning set 1). Other prompts affected: "4-20 RNG," "DEADBAND"
	TI CUR	**RELAY CURRENT DUPLEX (RELAY = COOL)** is similar to "CUR-TI" except that current is active for 50 to 100% and relay #1 is active for 0 to 50%. Other prompts affected: "4-20 RNG," "DEADBAND"

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685 709

4.5 Algorithm Data Set Up Group, Continued

Table 4-4 Algorithm Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
4-20 RNG		**CURRENT DUPLEX RANGE ALGORITHM** — Used with Output Algorithm selections "CUR-D," "CUR-TI", or "TI-CUR." For "CUR-TI" and "TI-CUR", this should be set to "50 PCT".
	50 PCT	**CURRENT DUPLEX RANGE (SPLIT)** For "CUR D" this enables the normal control current output to provide heat control and the Auxiliary output to provide cool control. To enable this, the auxiliary output must be: • Selected for Output • Auxiliary current output is scaled as desired for 0-50% controller output (4mA set to 50; 20mA set to 0). • Deadband for this configuration only applies to the current output. Auxiliary output must have Deadband scaled in. For example: If a 2% Deadband is desired, then enter a "2.0" for the "Deadband" selection in the Control Algorithm Group. This will apply Deadband to the Current Output. In the "Options" group, set the Auxiliary Output "4mA" selection to "49.0" and the "20mA" selection to 0.0. Other prompts affected: "AUX OUT"
	100PCT	**CURRENT DUPLEX RANGE (FULL)** enables the normal control current output to provide duplex heat and cool control over 0 - 100% of the controller output. The PID heat parameters apply when the controller output is greater than 50% and the PID cool parameters apply when the controller output is less than 50%.
RLY TYPE		**RELAY TYPE** – For Time Proportional only
	MECHAN	ELECTROMECHANICAL RELAY – This selection allows cycle times of from 1 to 120 seconds.
	SOL ST	SOLID STATE RELAY OR OPEN COLLECTOR OUTPUT – This selection allows cycle times of 0.333 seconds through 40.0 seconds in 0.333 second increments. **ATTENTION** Lockout must be set to "NONE" to view this prompt.

4.6 Input 1 Parameters Set Up Group

Introduction

These are the parameters required for input 1; temperature units, decimal location, actuation, transmitter characterization, high and low range values in engineering units, filter, burnout, emissivity, and power line frequency.

Input 1 group prompts

Table 4-5 lists all the function prompts in the Input 1 setup group and their definitions.

Table 4-5 Input 1 Group definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
DECIMAL		DECIMAL POINT LOCATION – This selection determines where the decimal point appears in the display.
	XXXX XXX.X XX.XX	None One Place Two Places
		NOTE: Auto-ranging will occur when one decimal position has been selected and the value increases above 999.9 but auto-ranging *will not* similarly occur when two decimal positions are selected.
UNITS		TEMPERATURE UNITS -- This selection will be indicated on the annunciator. What display of temperature do you want:
	DEG F DEG C NONE	Degrees Fahrenheit Degrees Celsius None

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685 711

4.6 Input 1 Parameters Set Up Gr up, Continued

Table 4-5 Input 1 Group definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
IN1 TYPE		**INPUT 1 ACTUATION TYPE** -- This selection determines what actuation you are going to use for input one.
	B TC	B thermocouple 0 to 3300°F −18 to 1815°C
	E TC H	E thermocouple high −454 to 1832°F −270 to 1000°C
	E TC L	E thermocouple low −200 to 1100°F −129 to 593°C
	J TC H	J thermocouple high 0 to 1600°F −18 to 871°C
	J TC L	J thermocouple low 20 to 770°F −7 to 410°C
	K TC H	K thermocouple high 0 to 2400°F −18 to 1316°C
	K TC L	K thermocouple low −20 to 1000°F −29 to 538°C
	NNM H	NiNiMo thermocouple high 32 to 2500°F 0 to 1371°C
	NNM L	NiNiMo thermocouple low 32 to 1260°F 0 to 682°C
	NIC TC	*Nicrosil-Nisil thermocouple* 0 to 2372°F −17.8 to 1300°C
	R TC	R thermocouple 0 to 3100°F −18 to 1704°C
	S TC	S thermocouple 0 to 3100°F −18 to 1704°C
	T TC H	T thermocouple high −300 to 700°F −184 to 371°C
	T TC L	T thermocouple low −200 to 500°F −129 to 260°C
	W TC H	W5W26 thermocouple high 0 to 4200°F −18 to 2316°C
	W TC L	W5W26 thermocouple low 0 to 2240°F −18 to 1227°C
	100 PT	100 Ohm-RTD −300 to 1200°F −184 to 649°C
	500 PT	500 Ohm-RTD −300 to 1200°F −184 to 649°C
	100 LO	100 Ohm RTD low 0 to 300°F −18 to 149°C
	RADIAM	Radiamatic (RH) 1400 to 3400°F 760 to 1871°C
	4-20mA	4 to 20 Milliamps
	0-10mV	0 to 10 Millivolts
	10-50m	10 to 50 Millivolts
	1-5 V	1 to 5 Volts
	0-10 V	0 to 10 Volts

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4.6 Input 1 Parameters Set Up Group, Continued

Table 4-5 Input 1 Group definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
XMITTER	Select one from the columns below B TC — S TC E TC H — T TC H E TC L — T TC L J TC H — W TC H J TC L — W TC L K TC H — 100 PT K TC L — 500 PT NNM H — 100 LO NNM L — RADIAM NIC TC — LINEAR R TC — SQROOT	**TRANSMITTER CHARACTERIZATION** — This selection lets you instruct the controller to characterize a linear input to represent a non-linear one. NOTE: Prompt only appears when a linear actuation is selected at prompt "IN1 TYPE". FOR EXAMPLE: If input 1 is a 4 to 20 mA signal, but the signal represents a type "K" thermocouple; select "K TC H" and the controller will characterize the 4 to 20 mA signal so that it is treated as a type "K" thermocouple input (high range). Parameter definitions are the same as shown in Lower Display Prompt "IN1 TYPE"
IN1 HI	−999.9 to 9999. or −999 to 9999 in Engineering units	**INPUT 1 HIGH RANGE VALUE** in engineering units is displayed for all inputs but can only be configured for linear or square root transmitter characterization. Scale the #1 input signal to the display value you want for 100%. EXAMPLE: Actuation (Input) = 4 to 20 mA Process Variable = Flow Range of Flow = 0 to 250 Gal/Min High Range display value = 250 Then 20 mA = 250 Gal/Min The control setpoint will be limited by the range of units selected here.
IN1 LO	−999.9 to 999. or −999 to 9999 in Engineering units	**INPUT 1 LOW RANGE VALUE** in engineering units is displayed for all inputs but can only be configured for linear or Square Root transmitter characterization. Scale the #1 input signal to the display value you want for 0%. See example on previous page. The control setpoint for Input 1 will be limited by the range of units selected here.
BIAS IN1	−999.9 to 9999	**BIAS ON INPUT 1** — Bias is used to compensate the input for drift of an input value due to deterioration of a sensor, or some other cause. Select the bias value you want on input one.

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685 713

4.6 Input 1 Parameters Set Up Group, Continued

Table 4-5 Input 1 Group definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
FILTER 1	0 to 120 seconds No filter = 0	**FILTER FOR INPUT ONE** — A software digital filter is provided for input 1 to smooth the input signal. You can configure the first order lag time constant from 1 to 120 seconds. If you do not want filtering, enter 0.
BURNOUT		**BURNOUT PROTECTION (SENSOR BREAK)** provides most input types with upscale or downscale protection if the input fails. 1-5V, 0-10V, or 4-20mA inputs require no burnout or "NONE" selection.
	NONE	**NO BURNOUT** — Pre-configured Failsafe output applied if failed input is detected. Error message "INPUT1 FAIL" is flashed on the lower display intermittently every 10 seconds.
	UP	**UPSCALE BURNOUT** will make the PV signal increase to full scale when a sensor fails, and flash "INPUT1 FAIL" on the lower display intermittently every 10 seconds. The controller remains in Automatic control mode and adjusts the controller output signal in response to the full scale PV signal developed by the Burnout circuitry.
	DOWN	**DOWNSCALE BURNOUT** will make the PV signal decrease to the lower range value when a sensor fails, and flash "INPUT1 FAIL" on the lower display intermittently every 10 seconds. The controller remains in Automatic control mode and adjusts the controller output signal in response to the zero percent PV signal developed by the Burnout circuitry.
		NOTE: For no Burnout, i.e. "None," to function properly on a 4-20MA input, there must be a dropping resistor directly across the *input* terminals (i.e., not remote), then the unit can detect the "zero" voltage that occurs when the 4-20 mA line is opened.
EMISSIV	0.01 to 1.00	**EMISSIVITY** is a correction factor applied to the Radiamatic input signal that is the ratio of the actual energy emitted from the target to the energy which would be emitted if the target were a perfect radiator. Available only for "Radiamatic" inputs.
PWR FREQ	 60 Hz 50 Hz	**POWER LINE FREQUENCY** — select whether your controller is operating at 60 Hz or 50 Hz. **60 HERTZ** **50 HERTZ**
LANGUAGE	ENGLISH FRENCH GERMAN SPANISH ITALIAN	

4.7 Input 2 Parameters Set Up Group

Introduction

These are the parameters required for input 2; actuation, transmitter characterization, high and low range values in engineering units, filter, and burnout.

Input 2 group prompts

Table 4-6 lists all the function prompts in the Input 2 setup group and their definitions.

Table 4-6 Input 2 Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
XMITTER2		TRANSMITTER CHARACTERIZATION — This selection lets you instruct the controller to characterize a linear input to represent a non-linear one. FOR EXAMPLE: If input 2 is a 4 to 20 mA signal, but you want the signal to represent a type "K" thermocouple; select " K TC H" and the controller will characterize the 4 to 20 mA signal so that it is treated as a type "K" thermocouple input.
	B TC E TC H E TC L J TC H J TC L K TC H K TC L NNM H NNM L NIC TC R TC S TC T TC H T TC L W TC H W TC L 100 PT 500 PT 100 LO RADIAM LINEAR SQROOT	B Type Thermocouple E Type Thermocouple High E Type Thermocouple Low J Type Thermocouple High J Type Thermocouple Low K Type Thermocouple High K Type Thermocouple Low NiNiMo Type Thermocouple High NiNiMo Type Thermocouple Low Nicrosil Nisil Thermocouple R Type Thermocouple S Type Thermocouple T Type Thermocouple High T Type Thermocouple Low W5W26 Type Thermocouple High W5W26 Type Thermocouple Low 100 Ohm–RTD 500 Ohm–RTD 100 Ohm RTD Low Radiamatic (RH) Linear Range Square Root

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685 715

4.7 Input 2 Parameters Set Up Gr up, Continued

Table 4-6 Input 2 Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
IN2 HI	−999.9 to 999. or −999 to 9999 in Engineering units	**INPUT 2 HIGH RANGE VALUE** in engineering units is displayed for all inputs but can only be configured for linear or square root actuations only. Scale the #2 input signal to the display value you want for 100%. This is what you want 20mA or 5 volts to represent. EXAMPLE: Same as input one.
IN2 LO	−999.9 to 999. or −999 to 9999 in Engineering units	**INPUT 2 LOW RANGE VALUE** in engineering units, for linear or Square Root characterization only. Scale the #2 input signal to the display value you want for 0%. This is what you want 4mA or 1 volt to represent. EXAMPLE: Same as input one.
FILTER 2	0 to 120 seconds No filter = 0	**FILTER FOR INPUT TWO** — A software digital filter is provided for input 2 to smooth the input signal. You can configure the first order lag constant from 1 to 120 seconds. If you do not want filtering, enter 0.

4.8 Control Parameters Set Up Gr up

Introduction

The functions listed in this group deal with how the UDC 3000 will control the process including: Number of tuning parameter sets, Setpoint source, Ratio, Bias, Tracking, Power-up recall, Setpoint limits, Output direction and limits, Deadband and Hysteresis.

Control group prompts

Table 4-7 lists all the function prompts in the Control setup group and their definitions.

Table 4-7 Control Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
PID SETS		NUMBER OF TUNING PARAMETER SETS — This selection lets you choose one or two sets of tuning constants (gain, rate, and reset).
	1 ONLY	ONE SET ONLY — Only one set of tuning parameters is available. Configure the values for: Gain (proportional band) Rate Reset Time Cycle Time (if time proportional is used)
	2KEYBD	TWO SETS KEYBOARD SELECTABLE — Two sets of tuning parameters can be configured and can be selected at the operator interface or by using the Digital Inputs. Press [LOWR DISP] key until you see "PID SET1" or "PID SET2" to switch between sets. Configure the values for: Gain, Rate , Reset, Cycle Time Gain #2, Rate #2, Reset#2, Cycle#2 Time
	2PV SW	TWO SETS PV AUTOMATIC SWITCHOVER — When the process variable is *GREATER* than the value set at prompt "SW VALUE" (Switchover Value), the controller will use Gain, Rate, Reset, and Cycle Time. The active PID SET can be read in the lower display. When the process variable is *LESS* than the value set at prompt "SW VALUE," the controller will use Gain #2, Rate #2, Reset #2, and Cycle #2 Time. The active PID SET can be read in the lower display. Other prompts affected: SW VALUE
	2SP SW	TWO SETS SP AUTOMATIC SWITCHOVER — When the setpoint is *GREATER* than the value set at prompt "SW VALUE" (Switchover Value), the controller will use Gain, Rate, Reset, and Cycle. When the setpoint is *LESS* than the value set at prompt "SW VALUE," the controller will use Gain #2, Rate #2, Reset #2, and Cycle #2. Other prompts affected: SW VALUE

Continued on next page

685 717

4.8 C ntr l Parameters Set Up Group, continued

Table 4-7 Control Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
SW VALUE	Value in engineering units	AUTOMATIC SWITCHOVER VALUE —This is the value of Process Variable or Setpoint at which the controller will switch from Tuning Constant Set #2 to Set #1. Only appears when PID SETS selections "2PV SW" or "2SP SW" are selected.
SP SOURC		SETPOINT SOURCE — This selection determines what your setpoint source will be; One local or Two local. Toggled by the "SETPOINT SELECT" key.
	1LOCAL	LOCAL SETPOINT — The setpoint entered from the keyboard.
	2LOCAL	TWO LOCAL SETPOINTS — This selection lets you switch between two local setpoints. Mutually exclusive with Remote setpoint.
RSP SRC		REMOTE SETPOINT — A signal is brought in through the input 2 terminals and used as the control setpoint. Ratio and Bias can be applied to the remote setpoint. Mutually exclusive with 2 Local setpoints Other prompts affected: RATIO, BIAS
	NONE IN 2	NONE - No remote setpoint IN 2 - RSP using second Input (Input 2 must be enabled)
RATIO	–20.00 to 20.00	RATIO — Used when input 2 operates as a remote setpoint, prompt "REMOTE." This ratio value can be applied to the remote setpoint. It establishes the correct relationship between the remote setpoint and the input 2 signal applied according to the formula below...(under Bias). Input 2 must be enabled.
BIAS	–9999 to 9999 (Engineering Units)	BIAS — Used when input 2 operates as a remote setpoint (prompt "REMOTE"). Bias, together with ratio, establishes the correct relationship between the remote setpoint and the input 2 signal applied according to the formula: REMOTE SETPOINT = IN2 VALUE (RATIO) + BIAS NOTE: IN2 VALUE = Actual (engineering units) All values must be within configured setpoint high and low limits. Input 2 must be enabled.

Continued on next page

4.8 Control Parameters Set Up Group, Continued

Table 4-7 Control Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
SP TRACK		**SETPOINT TRACKING** — The local setpoint can be configured to track either PV or RSP as listed below:
	NONE	**NO TRACKING** — If local setpoint tracking is not configured, the LSP will not be altered when transfer from RSP to LSP is made.
	PV	**LSP (LOCAL SETPOINT) TRACKS PV IN MANUAL**
	RSP	**LSP (LOCAL SETPOINT) TRACKS RSP (REMOTE SETPOINT) IN AUTO** — If configured, when the controller transfers out of remote setpoint, the last value of the remote setpoint (RSP) is inserted into the local setpoint.
POWER UP		**POWER UP CONTROLLER MODE RECALL** — This selection determines which mode and setpoint the controller will use when the controller restarts after a power loss. Select one from below:
	MANUAL	**MANUAL, LSP** — At power-up, the controller will use *manual* mode with the local setpoint displayed.
	A LSP	**AUTOMATIC, LOCAL SETPOINT** — At power-up, the controller will return to the *automatic* mode and will use the local setpoint for control.
	A RSP	**AUTOMATIC, REMOTE SETPOINT** — At power-up, the controller will return to the *automatic* mode and will use the remote setpoint for control.
	AM SP	**LAST MODE/LAST SETPOINT**
	AM LSP	**LAST MODE/LAST LOCAL SETPOINT**
SP HILIM	0 to 100% of span input in engineering units with decimal place	**SETPOINT HIGH LIMIT*** — This selection prevents the local and remote setpoints from going above the value selected here. The setting must be equal or less than the upper range of input 1 and input 2. Input 2, when configured for remote setpoint, will be restricted to this upper limit.
SP LOLIM	0 to 100% of span input in engineering units with decimal place	**SET POINT LOW LIMIT*** — This selection prevents the local and remote setpoints from going below the value selected here. The setting must be equal or greater than the lower range of input 1 and input 2. Input 2, when configured for remote setpoint, will be restricted to this lower limit.

*The Local Setpoint will automatically adjust itself to be within the setpoint limit range. For example, if SP = 1500 and the SP HILIM is changed to 1200, the new Local Setpoint will be 1200.

Continued on next page

685·719

4.8 Control Parameters Set Up Group, Continued

Table 4-7 Control Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
ACTION		**CONTROL OUTPUT DIRECTION** — In what direction do you want the controller output to go when the process variable increases.
	DIRECT	**DIRECT ACTING CONTROL** — The controller's output increases as the process variable increases.
	REVRSE	**REVERSE ACTING CONTROL** — The controller's output decreases as the process variable increases.
OUT RATE		**OUTPUT CHANGE RATE** - Enables or Disables the Output Change Rate. The maximum rate is set at Prompt "PCT/M UP" or "PCT/M DN" shown below.
	DISABL ENABLE	Disable Enable
PCT/M UP	0 to 9999%/minute	**OUTPUT RATE UP VALUE** - This selection limits the rate at which the output can change upward. Enter a value in percent/minute. Appears only if "OUT RATE" is enabled. "0" means no output rate applied.
PCT/M DN	0 to 9999%/minute	**OUTPUT RATE DOWN VALUE** - This selection limits the rate at which the output can change downward. Enter a value in percent/minute. Appears only if "OUT RATE" is enabled. "0" means no output rate.
OUTHILIM	–5.0 to 105.0% of output	**HIGH OUTPUT LIMIT** — This is the highest value of output beyond which you do not want the controller automatic output to exceed. Use 0 to 100% for time proportional output type.
OUTLOLIM	–5.0 to 105.0% of output	**LOW OUTPUT LIMIT** — This is the lowest value of output below which you do not want the controller automatic output to exceed. Use 0 to 100% for time proportional output type.
DROPOFF	–5 to 105.0% of output	**CONTROLLER DROPOFF VALUE** — Select an output value that below which the controller output will dropoff to the low output limit value set in prompt "OUT LOLIM." DROPOFF is not displayed if On-Off or 3 Position Step is configured.
DEADBAND		**DEADBAND** is an adjustable gap between the operating ranges of output 1 and output 2 in which neither output operates (positive value) or both outputs operate (negative value). It is the difference between the nominal trip points of relay 1 and relay 2.
	–5.0 to 25.0% 0 to 25.0% 0.5 to 5.0%	Time Duplex On-Off Duplex Position Proportional and Three Position Step

Continued on next page

4.8 Control Parameters Set Up Group, continued

Table 4-7 Control Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
OUT HYST	0.0 to 5.0% of PV span	**HYSTERESIS (OUTPUT RELAY ONLY)** is an adjustable overlap of the ON/OFF states of each control output. This is the difference between the value of the process variable at which the control outputs energize and the value at which they de-energize. Only applicable for ON-OFF control.
FAILSAFE	0 to 100%	**FAILSAFE OUTPUT VALUE** — The value used here will also be the output level when you have Communications SHED or when NO BURNOUT is configured and input 1 fails.
MAN OUT	0 to 100%	**POWER UP PRESET MANUAL OUTPUT** — At power -up, the controller will go to manual, and the Output value set here.
AUTO OUT	0 to 100%	**POWER UP PRESET AUTOMATIC OUTPUT** — At power -up, the controller will begin its automatic control at the Output value set here.
PBorGAIN		**PROPORTIONAL BAND UNITS** — Select one of the following for the Proportional (P) term of the PID algorithm:
	PB PCT	**PROPORTIONAL BAND** — Selects units of percent proportional band for the P term of the PID algorithm. Where: $PB\% = \frac{100\%FS}{GAIN}$
	GAIN	**GAIN** selects the unitless term of gain for the P term of the PID algorithm. Where: $GAIN = \frac{100\%FS}{PB\%}$
MINorRPM		**RESET UNITS** — Selects units of minutes or repeat per minutes for the I term of the PID algorithm. 20 Repeats per Minute = 0.05 Minutes per Repeat.
	RPM	**REPEATS PER MINUTE** — The number of times per minute that the proportional action is repeated by reset.
	MIN	**MINUTES PER REPEAT** — The time between each repeat of the proportional action by reset.

685 721

4.9 Options Set Up Group

Introduction

Configure the remote mode switch (Digital Inputs) to a specific contact closure response, or configure the Auxiliary Output to be a specific selection with desired scaling.

Table 4-8 lists all the function prompts in the Option setup group and their functions.

Table 4-8 Option Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
AUX OUT		**AUXILIARY OUTPUT SELECTION** provides an mA output representing any of six control parameters. The display for auxiliary output viewing will be in engineering units for Input 1, Input 2, Process Variable, Deviation, and Setpoint. Output will be displayed in percent. Other prompts affected by these selections: "4mA VAL" and "20mA VAL."
	DISABL	**NO AUXILIARY OUTPUT**
	IN 1	**INPUT 1** — This represents the configured range of input 1. FOR EXAMPLE: Type "J" Thermocouple (0 to 1600°F) 0°F display = 0% output 1600°F display = 100% output
	IN 2	**INPUT 2** represents the value of the configured range of input 2.
	PV	**PROCESS VARIABLE** — Represents the value of the Process Variable. PV = Input 1 + Bias
	DEV	**DEVIATION (PROCESS VARIABLE MINUS SETPOINT)** — Represents −100 to +100% of the selected PV span in engineering units. FOR EXAMPLE: Type "T" Thermocouple PV range = −300 to +700°F PV span = 1000°F Deviation Range = −1000 to +1000°F If PV = 500°F and SP = 650°F then Deviation Display = −150°F Auxiliary Output = 42.5% NOTE: A deviation of 0°F yields an auxiliary output of 50%.
	OUTPUT	**OUTPUT** — Represents the displayed controller output in percent (%). Cannot be used with 3 Position Step Control.
	SP	**SETPOINT** — Represents the value of the setpoint in units of PV.

Continued on next page

4.9 Options Set Up Group, Continued

Table 4-8 Option Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
4mA VAL	Low Scale Value within the range of the selected variable to represent 4 mA	**AUXILIARY OUTPUT LOW SCALING FACTOR** — Use a value in engineering units for: Input 1, Input 2, Process Variable, Deviation, and Setpoint. Use value in percent (%) for Output. (Output can be between –5 and +105%.)
20mA VAL	High Scale Value within the range of the selected variable to represent 20 mA	**AUXILIARY OUTPUT HIGH SCALING FACTOR** — Use a value in engineering units for: Input 1, Input 2, Process Variable, Deviation,* and Setpoint. Use a value in percent (%) for Output. (Output can be between –5 and +105%.) *When Deviation is selected, only one operating parameter will be entered. This value represents the deviation level that will produce 20 mA output. Zero deviation will produce a center scale (12 mA) output. A negative deviation equal in magnitude to the Auxiliary Output High Value will produce a low end (4 mA) output.
DIG IN 1 DIG IN 2		**DIGITAL INPUT SELECTIONS** — All selections are available for either input. The controller returns to its original state when contact opens, except when overruled by the keyboard.
	NONE	**NO DIGITAL INPUT SELECTIONS**
	To MAN	**TO MANUAL** — Contact closure puts the controller into manual mode. Contact open returns controller to former mode unless AUTO/MAN key is pressed while digital input is active.
	To LSP	**TO LOCAL SETPOINT** — Contact closure puts the controller into local setpoint 1. When contact opens, the controller returns to former operation local or remote setpoint unless Setpoint Select key is pressed while digital input is active.
	To 2SP	**TO LOCAL SETPOINT TWO** — Contact closure puts the controller into local setpoint 2.
	To DIR	**TO DIRECT ACTION** — Contact closure selects direct controller action.
	ToHOLD	**TO HOLD** — Contact closure suspends Setpoint Program or Setpoint Ramp. Contact open runs program.
	ToPID2	**TO PID2** — Contact closure selects PID Set 2.

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685 723

4.9 Options Set Up Group, Continued

Table 4-8 Option Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
DIG IN 1 DIG IN 2 continued		
	PV 2IN	PV = INPUT 2-Contact Closure selects PV = Input 2.
	To RUN	RUN — Contact closure starts a stopped SP Program. Left character blinks "R"
	ToBEGN	EXTERNAL PROGRAM RESET — Contact closure resets SP Program back to the beginning of the first segment in the Program. Program cycle number is not affected.reopening switch has no effect NOTE: *Once the last segment of the setpoint program has timed out, the controller enters the mode of action specified in the configuration data and the program cannot be reset back to the beginning of the first segment by digital input closure.*
	STOP I	INHIBIT INTEGRAL (RESET) — Contact closure disables PID Integral (Reset) action.
	MAN/FS	MANUAL FAILSAFE – Unit goes to Manual Mode, output goes to the Failsafe value.
	To LOCK	KEYBOARD LOCKOUT — Contact closure disables all keys. Lower display shows "LOCKED" if a key is pressed.
	To A OUT	AUTOMATIC OUTPUT — Contact closure sends output to the value set at Control prompt "AUTO OUT".
DIG 1 COM DIG 2 COM		DIGITAL INPUT COMBINATIONS SELECTIONS — All selections are available can be combined with either input.
	DISABLE	DISABLES INPUT COMBINATIONS
	+PID2	ANY DIGITAL INPUT SELECTION PLUS TO PID2 — Contact closure selects PID Set 2.
	+To DIR	ANY DIGITAL INPUT SELECTION PLUS TO DIRECT ACTION — Contact closure selects direct controller action.
	+ToSP2	ANY DIGITAL INPUT SELECTION PLUS TO LOCAL SETPOINT TWO — Contact closure puts the controller into local setpoint 2.
	+DISAT	ANY DIGITAL INPUT SELECTION PLUS DISABLE ADAPTIVE TUNE — Contact closure disables Adaptive Tune process.

4.10 Communications Set Up Group

Introduction

This option allows the controller to be connected to a host computer via a RS422/485 or DMCS bus. Fifteen units can be configured over this link. The controller looks for messages from the computer at regular intervals. If these messages are not received within the configured shed time, the controller will SHED from the communications link and return to stand alone operation. The device address, parity, and baud rate are configurable. You can also set the SHED output mode and setpoint recall, and communication units.

Communications group prompts

Table 4-9 lists all the function prompts in the Communications setup group and their definitions.

Table 4-9 Communications Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
ComSTATE	RS-422/485 DMCS DISABL	**COMMUNICATIONS SELECTION** **RS-422/485** — Allows RS422/485 communication prompts. **DMCS** — Allows DMCS communication prompts. **DISABL** — Disables the communications option.
Com ADDR	1 to 99 (RS422) 1 to 99 (DMCS)	**COMMUNICATIONS STATION ADDRESS** — This is a number that is assigned to a controller that is to be used with the communications option.
SHEDTIME	0 to 255	**SHED TIME** — The number that represents how many sample periods there will be before the controller sheds from communications. Each period equals 1/3 seconds or 0 = No shed.
PARITY (RS422/485 only)	 ODD EVEN	**PARITY** pertains to the use of a self-checking code employing binary digits in which the total number of ONE's (or ZERO's) in each permissible code expression is either ODD or EVEN. **ODD PARITY** **EVEN PARITY**
BAUD (RS422/485 only)	 300 600 1200 2400 4800 9600 19200	**BAUD RATE** is the transmission speed in bits per second. **300 BAUD** **600 BAUD** **1200 BAUD** **2400 BAUD** **4800 BAUD** **9600 BAUD** **19200 BAUD**

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685 725

4.10 Communications Set Up Group, Continued

Table 4-9 Communications Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
DUPLEX **(RS422/485 only)**	 HALF FULL	**DUPLEX** - Transmission Type **HALF DUPLEX** - Two wires **FULL DUPLEX** - Four wires
LOOPBACK	 ENABLE DISABL	**LOCAL LOOPBACK** tests the communications hardware. **ENABLE** — Allows loopback test. The UDC goes into Loopback mode in which it sends and receives its own message. The UDC displays "PASS" or "FAIL" in the upper display and "LOOPTEST" in the lower display as long as the test is running. The UDC will go into manual mode. The test will run until the operator disables it here. **DISABLE** - disables the Loopback test.
SHEDMODE **(DMCS only)**	 LAST TO MAN FSAFE ToAUTO	**SHED CONTROLLER MODE AND OUTPUT LEVEL** — determines the mode of local control you want when the controller is shed from the communications link. **LAST** -SAME MODE AS BEFORE SHED - The controller will return to the same mode (manual or automatic) that it was in before shed. **TO MAN** — TO MANUAL MODE BUMPLESS OUTPUT - The controller will return to manual mode at the same output level that it had before shed. **FSAFE** — TO MANUAL MODE, FAILSAFE OUTPUT - The controller will return to manual mode at the output value selected at "CONTROL" prompt "FAILSAFE". **ToAUTO** — To automatic mode.
SHED SP **(DMCS only)**	 TO LSP TO CSP	**SHED SP** — Shed setpoint (DMCS only). **TO LSP** — Controller will use last local SP used. **TO CSP** — Controller will use computer setpoint.
UNITS	 PERCNT ENG	**COMMUNICATION UNITS** — This selection determines how the controller values are expressed during communications. **PERCENT OF SPAN** **ENGINEERING UNITS**

4.11 Alarms Set Up Group

Introduction

An alarm is an indication that an event that you have configured (for example—Process Variable) has exceeded one or more alarm limits. There are two alarms available. Each alarm has two setpoints. You can configure each of these two setpoints to alarm on various controller parameters.

There are two alarm output selections, High and Low. You can configure each setpoint to alarm either High or Low. These are called single alarms.

You can also configure the two setpoints to alarm on the same event and to alarm both high and low. A single adjustable Hysteresis of 0.0% to 5.0% is configurable for the alarm setpoint.

See Table 2-4 in the Installation section for Alarm relay contact information.

Alarms group prompts

Table 4-10 lists all the function prompts in the Alarms setup group and their definitions.

Table 4-10 Alarms Group Definitions

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
A1S1 VAL	Value in Engineering Units	**ALARM 1 SETPOINT 1 VALUE** — This is the value at which you want the alarm type chosen in Prompt "A1S1TYPE" to actuate. The value depends on what the setpoint has been configured to represent. NO setpoint is required for Communications SHED. For SP Programming the value is the segment number for which the event applies.
A1S2 VAL	Value in Engineering Units	**ALARM 1 SETPOINT 2 VALUE** — This is the value at which you want the alarm type chosen in Prompt "A1S2TYPE" to actuate. The details are the same as "A1S1 VAL".
A2S1 VAL	Value in Engineering Units	**ALARM 2 SETPOINT 1 VALUE** — This is the value at which you want the alarm type chosen in Prompt "A2S1TYPE" to actuate. The details are the same as "A1S1 VAL".
A2S2 VAL	Value in Engineering Units	**ALARM 2 SETPOINT 2 VALUE** — This is the value at which you want the alarm type chosen in Prompt "A2S2TYPE" to actuate. The details are the same as "A1S1 VAL".

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685·727.

Table 4-10 Alarms Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
A1S1TYPE		**ALARM 1 SETPOINT 1 TYPE** — Select what you want Setpoint 1 of Alarm 1 to represent. It can represent the Process Variable, Deviation, Input 1, Input 2, Output, and if you have a model with communications, you can configure the controller to alarm on SHED. If you have setpoint programming, you can alarm when a segment goes ON or OFF.
	NONE IN 1 IN 2 PV DEV OUTPUT SHED EV ON EV OFF	**NO ALARM** **INPUT 1** **INPUT 2** **PROCESS VARIABLE** **DEVIATION** **OUTPUT** (cannot be used with 3 Position Step control) **SHED FROM COMMUNICATIONS** **EVENT ON (SP PROGRAMMING)** **EVENT OFF (SP PROGRAMMING)**
A1S2TYPE	Same as A1S1 TYPE	**ALARM 1 SETPOINT 2 TYPE** — Select what you want Setpoint 2 of Alarm 1 to represent. The selections are the same as A1S1TYPE.
A2S1TYPE	Same as A1S1 TYPE	**ALARM 2 SETPOINT 1 TYPE** — Select what you want Setpoint 1 of Alarm 2 to represent. The selections are the same as A1S1TYPE. NOTE: Not applicable with Relay Duplex or Position Proportional outputs.
A2S2TYPE	Same as A1S1 TYPE	**ALARM 2 SETPOINT 2 TYPE** — Select what you want Setpoint 2 of Alarm 2 to represent. The selections are the same as A1S1TYPE. NOTE: Not applicable with Relay Duplex or Position Proportional outputs.
		ALARM 1 SETPOINT 1 STATE — Select whether you want the alarm type chosen in Prompt "A1S1TYPE" to alarm High or Low or the beginning or end of a segment in setpoint Ramp/Soak programming.
A1S1 H L A1S1 EV	HI LO BEGIN END	**HI ALARM** **LO ALARM** **BEGIN (SP PROGRAMMING)** **END (SP PROGRAMMING)**

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4.11 Alarms Set Up Group, Continued

Table 4-10 Alarms Group Definitions, continued

Lower Display Prompt	Upper Display Range of Setting or Selection	Parameter Definition
		ALARM 1 SETPOINT 2 STATE — Select whether you want the alarm type chosen in Prompt "A1S2TYPE" to alarm High or Low or the beginning or end of a segment in setpoint Ramp/Soak programming.
A1S2 H L A1S2 EV	H LO BEGIN END	HI ALARM LO ALARM BEGIN (SP PROGRAMMING) END (SP PROGRAMMING)
		ALARM 2 SETPOINT 1 STATE — Select whether you want the alarm type chosen in Prompt "A2S1TYPE" to alarm HIGH or LOW or the beginning or end of a segment in setpoint Ramp/Soak programming.
A2S1 H L A2S1 EV	H LO BEGIN END	HI ALARM LO ALARM BEGIN (SP PROGRAMMING) END (SP PROGRAMMING)
		ALARM 2 SET POINT 2 STATE — Select whether you want the alarm type chosen in Prompt "A2S2TYPE" to alarm HIGH or LOW or the beginning or end of a segment in setpoint Ramp/Soak programming.
A2S2 H L A2S2 EV	H LO BEGIN END	HI ALARM LO ALARM BEGIN (SP PROGRAMMING) END (SP PROGRAMMING)
AL HYST	0.0 to 5.0% of span or full output as appropriate	**ALARM HYSTERESIS** — A single adjustable hysteresis is provided on alarms such that when the alarm is OFF it activates at exactly the alarm setpoint; when the alarm is ON, it will not deactivate until the variable is 0.0% to 5.0% away from the alarm setpoint. Configure the hysteresis of the alarms based on INPUT signals as a % of input range span. Configure the hysteresis of the alarm based on OUTPUT signals as a % of the full scale output range.

685 729

4.12 Calibration Data

Introduction

The prompts used here are for field calibration purposes. Refer to *Section 7 – Calibration* in this manual for complete information.

4.12 Status Test Data

Introduction

The prompts used here are for determining the reason for a controller failure. Refer to the *Section 9 – Troubleshooting* in this manual for complete information.

685 730

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685 731

Section 5 – Operation

5.1 Overview

Introduction

This section gives you all the information necessary to monitor and operate your controller. Review the Operator Interface shown in "Monitoring" to make sure you are familiar with the indicator definitions. The key functions are listed in *Section 1 - Overview*.

What's in this section?

This section contains the following topics:

5.2 How to Power Up The Controller

Apply power

When power is applied, the controller will run three diagnostic tests. All the displays will light and then the controller will go into automatic mode.

Diagnostic tests

Table 5-1 lists the three diagnostic tests.

Table 5-1 Power Up Diagnostic Tests

Prompt on Lower Display	Condition
RAM TEST	Check RAM
CONFTEST	Check Non-volatile memory
CAL TEST	Check Calibration

Test failures

If one or more of these tests fail, the controller will go to the Fail-safe Manual Mode, and "FAILSAFE" will flash in the lower display.

If the output type is Position Proportional, and AUTO-CAL has never been done, a prompt "CALMTR" will appear suggesting that the controller be calibrated.

Troubleshooting

Refer to "STATUS TESTS" in *Section 9 - Troubleshooting* to identify and correct the problem.

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685 733

5.2 How to Power Up The Controller, Continued

Check the displays and keys

Use the procedure in Table 5-2 to run the display and key test.

Table 5-2 Procedure for Testing the Displays and Keys

<table>
<tr><th>Press</th><th>Result</th></tr>
<tr><td>[SET UP]
and hold in,
then
[FUNCTION]
at the same time</td><td>The controller will run a display test. All the displays will light for 8 seconds, then the displays will look like this:
Upper Display
[keys]
Lower Display
[try all]</td></tr>
<tr><td>Press each key to see if it works</td><td>When the key is pressed, the lower display will indicate the name of the key pressed.
<table>
<tr><th>Key Pressed</th><th>Lower Display</th></tr>
<tr><td>FUNCTION</td><td>FUNCTION</td></tr>
<tr><td>LOWER DISPLAY</td><td>LWR DISP</td></tr>
<tr><td>MANUAL/AUTO</td><td>AUTO MAN</td></tr>
<tr><td>SETPOINT/SELECT</td><td>SP SEL</td></tr>
<tr><td>▲</td><td>INCRMENT</td></tr>
<tr><td>▼</td><td>DECRMENT</td></tr>
<tr><td>RUN/HOLD</td><td>RUN HOLD</td></tr>
<tr><td>▲+▼</td><td>INCRDECR</td></tr>
<tr><td>FUNCTION+SETUP</td><td>FUNC SU</td></tr>
</table>
</td></tr>
</table>

If no key is presses for 20 seconds, the test will time out and the controller will go into control mode.

If any test fails, go to "Controller Failure Symptoms" in *Section 9 - Troubleshooting*.

Key error

When a key is pressed and the prompt "KEY ERROR" appears in the lower display, it will be for one of the following reasons:
- parameter not available,
- not in Set Up mode, press [SET UP] key first,
- Key malfunction, do keyboard test.

5.3 Enter a Security Code

Introduction

The LOCKOUT feature in the UDC3000 is used to inhibit changes (via keyboard) of certain functions or parameters by unauthorized personnel. There are different levels of LOCKOUT depending on the level of security required. These levels are:

NONE
CALIBRATE
+CONF
+VIEWING
MAXIMUM

See *Section 4 - Configuration Definitions* for details.

Security code numbers

The level of keyboard lockout may be changed in the Set Up mode. However, knowledge of a security code number (1 to 4095) may be required to change from one level of lockout to another.
When a controller leaves the factory, it has a security code of 0 which permits changing from one lockout level to another without entering any other code number.

Procedure

If you require the use of a security code, select a number from 0001 to 4095 and enter it when the lockout level is configured as "NONE".
Thereafter, that selected number must be used to change the lockout level from something other than "NONE".

CAUTION Write the number on the Configuration Record Sheet in the configuration section so you will have a permanent record.

Use the procedure in Table 5-3 to enter a security code.

Table 5-3 Procedure for Entering a Security Code

Step	Press	Action
1	SET UP	Until you see Upper Display: SET UP Lower Display: TUNING
2	FUNCTION	Until you see Upper Display: 0 Lower Display: SECURITY
3	▲ or ▼	to enter a four digit number in the upper display (1 to 4095) This will be your security code.

685 735

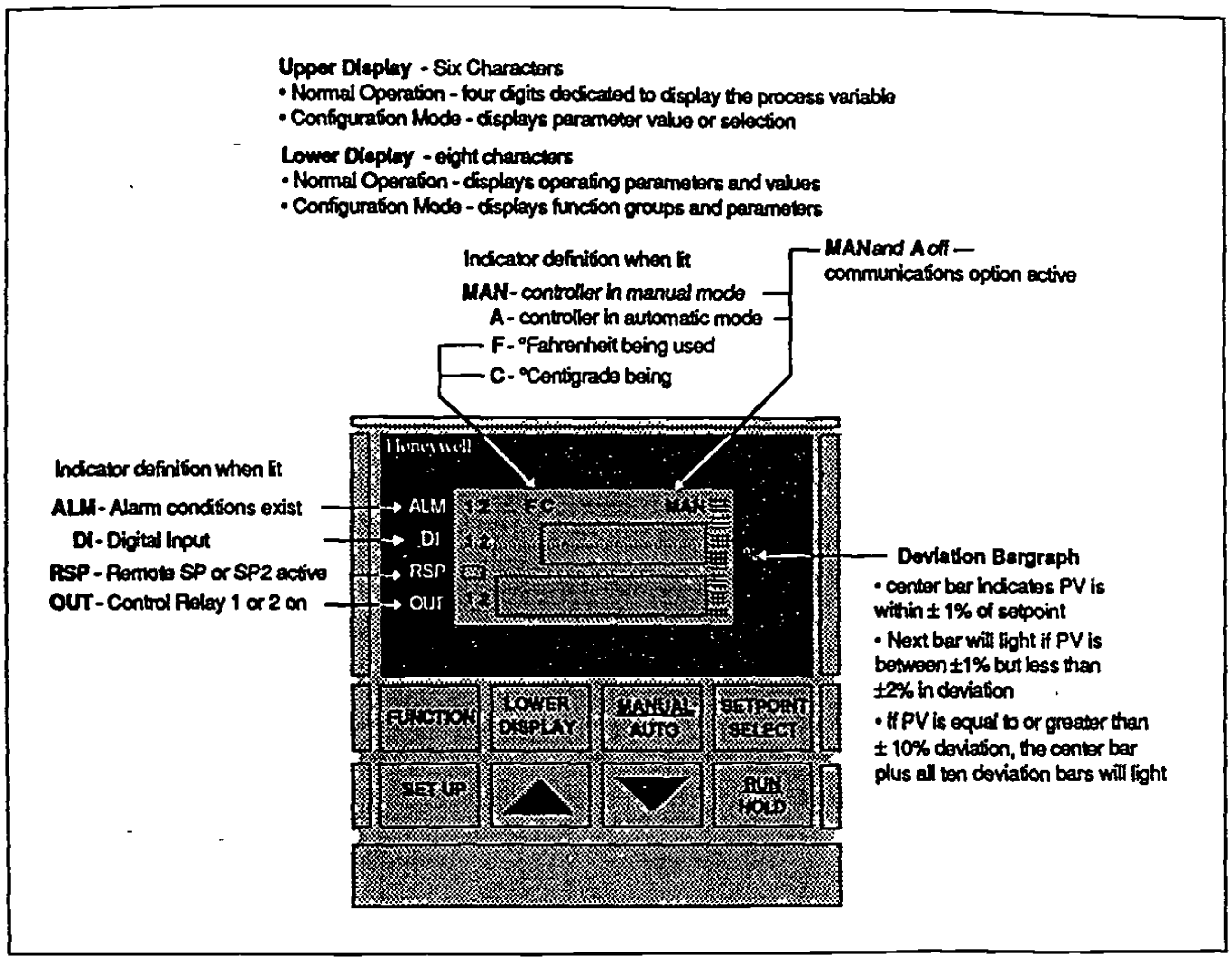
5.4 Monitoring Your Contr ller

Operator Interface

The indicators and displays on the Operator Interface let you see what is happening to your process and how the controller is responding.

Figure 5-1 is a view of the Operator interface. A description of the displays and indicators is included.

Figure 5-1 Operator Interface



Decimal point position

In each display, when no decimal place is configured, the right-most character is blank.

When a single decimal position has been configured and values greater than 1000 are displayed, the right-most character is blank but the decimal point will be lit.

Continued on next page

5.4 Monitoring Your Contr ller, continued

Viewing the operating parameters

Press the [LOWER DISPLAY] key to scroll through the operating parameters listed in Table 5-4.
The lower display will show only those parameters and its value that apply to your specific model and the way in which it was configured.

Table 5-4 Lower Display Key Parameter Prompts

Prompt	Description
SP **	Local Setpoint 1
2SP **	Local Setpoint 2 (where remote setpoint does not apply)
RSP	Remote Setpoint (when available)
2IN	Input 2
DEV	PV deviation from setpoint (±999.9 maximum)
ZZRAXX.XX	Time remaining in Setpoint Ramp ZZ = Segment Number XX.XX = Hrs/Minutes
ZZSKXX.XX	Time remaining in Setpoint Soak ZZ = Segment Number XX.XX = Hrs/Minutes
PIDSETX **	Tuning Parameter Set X=1 or 2
OUT **	Output Value in Percent (%); also 3PStep estimated motor position when no slidewire exists
CSP	Computer Setpoint (when setpoint is in override)
SPn	Setpoint Now (for setpoint rate)
POS	3 Position Step motor position when slidewire is connected

** You can press ▲ or ▼ to change the value of this parameter.

Continued on next page

5.4 Monitoring Your Controller, Continued

Diagnostic error messages

The UDC3000 performs background tests to verify data and memory integrity. If there is a malfunction, an error message will be displayed.

In the case of more than one simultaneous malfunctions, only the one with the highest priority will appear on the lower display.

A list of error messages is contained in Table 5-5.

If any of these error messages occur, refer to *Section 9 - Troubleshooting* for information to correct the failure.

Table 5-5 Error Messages

Prompt	Description
EE FAIL	Unable to write to non-volatile memory
FAILSAFE	Failsafe
INP1FAIL	Two consecutive failures of input 1 integration
INP2FAIL	Two consecutive failures of input 2 integration
SW FAIL	Position Proportional slidewire input failure
CONF ERR	Low limit greater than high limit for PV, SP, Reset or Output
INP1 RNG	Input 1 out-of-range Linear: ±10% out-of-range Characterized: ±1% out-of-range
INP2 RNG	Input 2 ±10% out-of-range
PV LIMIT	PV ±10% out-of-range
RV LIMIT	Remote Variable out-of-range Note: RV = (input 1 x ratio) + bias

685 738

5.5 Start Up Procedure

Procedure

The Start-up procedure is given in Table 5-6.

Table 5-6 Procedure for Starting Up the Controller

Step	Operation	Press	Action
1	Select manual mode	MANUAL AUTO	until "MAN" indicator is ON. The controller is in manual mode.
2	Adjust the output	▲ or ▼	to adjust the output value and ensure that the final control element is functioning correctly. Upper Display — shows the PV value Lower Display — shows OUT and the output value in %.
3	Tune the controller	SET UP	Make sure the controller has been configured properly and all the values and selections have been recorded on the Configuration Record Sheet. To tune your controller manually, see Section 11 - Appendix B Refer to Set Up group "TUNING" to ensure that the proper selections for PROP BD or GAIN, RATE MIN, and RSET MIN or RSET RPM have been entered. For controllers with ADAPTIVE TUNE, see the procedure in this section.
4	Enter the local setpoint	LOWER DISPLAY	Upper Display — shows the PV Value Lower Display — SP and the local setpoint value
		▲ or ▼	To adjust the local setpoint to the value at which you want the process variable maintained. The local setpoint cannot be changed if the Setpoint Ramp function is enabled. "H" or "R" appears in the upper display.
5	Select Automatic Mode	MANUAL AUTO	until "A" indicator is ON. The controller is in Automatic mode. The controller will automatically adjust the output to maintain the process variable at setpoint, if the controller is properly tuned.

685 739

5.6 Operating Modes

Available modes

The controller can operate in any of three basic modes:

- Manual
- Automatic with Local Setpoint
- Automatic with Remote Setpoint

Manual and Automatic with Local set point are standard features and Automatic with Remote Setpoint is optional.

Mode definitions

Table 5-7 lists the three modes and their definitions.

Table 5-7 Operating Mode Definitions

Operating Mode	Definition
MANUAL	When switched to manual mode, the controller holds its output at the last value used during automatic operation and stops adjusting the output for changes in setpoint or process variable. Instead, you adjust the output by changing the value shown in the lower display. See *"Selecting Modes"*.
AUTOMATIC with LOCAL SETPOINT	In automatic local mode, the controller will operate from the local setpoint and automatically adjust the output to maintain the setpoint at the desired value. In this mode you can adjust the setpoint. See 5.7 - *"Setpoints"*.
AUTOMATIC with REMOTE SETPOINT	In automatic remote mode, the controller will operate from the setpoint measured at input 2. Adjustments are available to ratio this input and add a constant bias before it is applied to the control equation. See *Section 3 - Configuration, Set up group "Control"*.

What happens when you change modes

Table 5-8 explains what happens to the controller when you switch from one mode to another.

Table 5-8 Changing Operating Modes

Mode Change	Description
Manual to Automatic Local Setpoint	The local setpoint is usually the value previously stored as the local setpoint. PV Tracking is a configurable feature which modifies this. When it is selected, the local setpoint value tracks the process variable value continuously while in manual. LSP=PV at the moment you switch from manual to automatic. LSP holds at this one value.
Manual or Auto Local to Automatic Remote SP	The second input value with Ratio and Bias applied is used to calculate the control setpoint.
Automatic Remote SP to Manual or Auto Local Setpoint	If configured for Local Setpoint Tracking, when the UDC transfers out of remote setpoint, the last value of the control setpoint is inserted into the local setpoint. If LSP tracking is not configured, the local setpoint will not be altered when the transfer is made.

Continued on next page

5.6 Operating Modes, Continued

Selecting Manual or Automatic mode

An alternate action switch places the controller in Automatic or Manual mode of operation.

Switching between manual and automatic will be bumpless, except when PD+MR algorithm is selected.

Table 5-9 includes procedures for selecting automatic or manual mode and changing the output while in manual.

Table 5-9 Procedure for Selecting Automatic or Manual Mode

Step	Operation	Press	Action
1	Selecting Automatic Mode	MANUAL AUTO	until "A" indicator is ON. The controller regulates its output to maintain the PV at the desired setpoint. Upper Display — shows the PV value Lower Display — shows SP and the setpoint value The deviation bargraph indicates the PV deviation from the setpoint.
2	Selecting Manual Mode	MANUAL AUTO	until "MAN" indicator is ON. The controller holds its output at the last value used during automatic operation and stops adjusting the output for changes in setpoint or process variable. Upper Display — shows the PV value Lower Display — shows OUT and the output value in (%). The deviation bargraph indicates the PV deviation from the setpoint.
3	Adjust the Output in Manual Mode	▲ or ▼	to adjust the output value while in manual mode. Upper Display — shows the PV value Lower Display — shows OUT and the output value in %.
4	Return to Automatic Mode	MANUAL AUTO	The "A" indicator will appear indicating Automatic mode.

Continued on next page

685 741

5.6 Operating Modes, Continued

Position Proportional Backup mode

This feature provides for Position Proportional models to automatically change to a Three Position Step algorithm if the slidewire input signal fails. This will maintain control of your process.

"IN2 RNG" or "SWFAIL" will flash in the lower display and the "OUT" display will show a estimated motor position WITHOUT a decimal point.

5.7 Setpoints

Introduction

You can configure the following setpoints for the UDC3000 controller.

- A single local setpoint
- 2 local setpoints
- A local setpoint and a remote setpoint (Remote setpoint is an option)

These setpoint can be toggled by the [SETPOINT/SELECT] key.

Selecting the local setpoint source

Use the procedure in table 5-10 to select a single local setpoint source or two local setpoints.

Table 5-10 Procedure for Selecting the Local Setpoint Source

Step	Operation	Press	Action
1	Enter Set Up mode	[SET UP]	until the displays read: Upper Display: [SET UP] Lower Display: [CONTROL]
2	Display Local Setpoint Source selections	[FUNCTION]	until the displays read: Upper Display: Setpoint source selections 1 LOCAL 2 LOCAL Lower Display: [SP SOURC]
3	Select the desired source	▲ or ▼	to select the desired setpoint source in the upper display.
4	Return to control	[LOWER DISPLAY]	The controller will assume normal control.

Changing the local setpoints

Use the procedure in Table 5-11 to change either of the local setpoint value.

Table 5-11 Procedure for Changing the Local Setpoints

Step	Operation	Press	Action
1	Select the setpoint	[LOWER DISPLAY]	until you see Upper Display: The PV value Lower Display: SP or 2sp and the local setpoint value
2	Change the value	▲ or ▼	to change the local setpoint to the value at which you want the process maintained. The deviation bargraph indicates PV deviation from setpoint.

Continued on next page

685 743

Enabling (or disabling) the remote setpoint

Use the procedure in Table 5-12 to enable the remote setpoint source as Input 2.

Table 5-12 Procedure for Enabling (or disabling) the Remote Setpoint

Step	Operation	Press	Action
1	Select Set Up Group	SET UP	Until you see: Upper Display SET UP Lower Display CONTROL
2	Select the Remote Setpoint Source Prompt	FUNCTION	Until you see: Upper Display [◄] The Remote Setpoint source selection Lower Display RSP SRC NONE - not used IN 2 - Input 2 as RSP
3	Change selection	▲ or ▼	to enable or disable the remote setpoint.
4	Return to normal operation	LOWER DISPLAY	This will return the controller to normal operation.

Switching between setpoints

You can switch between Local and Remote setpoints or between two Local setpoints when configured. Use the procedure in Table 5-13 to switch between setpoints.

Table 5-13 Procedure for Switching Between Setpoints

Step	Operation	Press	Action
1	Switch between Setpoints	SETPOINT SELECT or LOWER DISPLAY	alternately select Local setpoint 1 and Remote setpoint or switch between the 2 Local Setpoints. or until you see the desired setpoint indicated ATTENTION "KEY ERROR" will appear in the lower display if the remote setpoint or 2nd local setpoint is not configured as a setpoint source, or if you attempt to change the setpoint while a setpoint ramp is enabled.
2	Change the Local setpoint value	▲ or ▼	The REMOTE setpoint cannot be changed at the keyboard.

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5.7 Setpoints, Continued

Setpoint selection indication

Table 5-14 shows how the indicators react and what the displays show for each type of setpoint.

Table 5-14 Setpoint Selection Indication

	Using Local Setpoint	Using Remote Setpoint	Using 2nd Local Setpoint
RSP Indicator	OFF	ON	ON
Upper Display	PV	PV	PV
Lower Display	SP and the Local Setpoint Source	RSP and Remote Setpoint Value	SP2 and the 2nd Local Setpoint Value

685 745

5.8 Setpoint Rate

Configuration

You can configure a Setpoint Ramp Rate that will apply to any Local setpoint change immediately.

Refer to the Configuration Section to enable the ramp and set an upscale or downscale rate value.

Make sure SP RAMP and SP PROG are disabled.

Operation

When a Local setpoint change is made, the controller will ramp from the original setpoint to the new one at the rate specified. This changing (current) setpoint can be viewed on the lower display.

Press the [LOWER DISPLAY] key until you see SPn and the setpoint value in the lower display.

5.9 Single Setpoint Ramp

Configuring the setpoint ramp

You can configure a single setpoint ramp to occur between the current local setpoint and a final local setpoint over a time interval of from 1 to 255 minutes. You can RUN or HOLD the ramp at any time.

Procedure

Table 5-15 lists the procedure for configuring the Setpoint Ramp parameters. The procedure for SP Program is in *Section 6 – Setpoint Programming Option.*

Table 5-15 Procedure for Configuring a Setpoint Ramp

Step	Operation	Press	Action
1	Select SP RAMP Set Up Group	SET UP	Until you see: Upper Display SET UP Lower Display SP RAMP
2	Select the Setpoint Ramp function	FUNCTION	Until you see: Upper Display DISABL Lower Display SP RAMP
3	Enable Setpoint Ramp	▲	Until you see: Upper Display ENABLE Lower Display SP RAMP NOTE: You cannot change the current local setpoint if the setpoint ramp function is enabled. Make sure SP RATE and SP PROG are disabled.
4	Set the Ramp Time	FUNCTION	Until you see: Upper Display [ ] ← The ramp time in minutes Lower Display TIME MIN
		▲ or ▼	to change the upper display value to the number of minutes in which you want the final setpoint to be reached. Setting Range = 1 to 255 minutes NOTE: Entering "0" will imply an immediate step change to the final SP.
5	Set the Final Setpoint value	FUNCTION	Upper Display [ ] ← The Final Setpoint value Lower Display FINAL SP
6		▲ or ▼	to change the upper display value to the desired final setpoint value. Setting Range = within the setpoint limits

Continued on next page

685 747

5.9 Single Setpoint Ramp, Continued

Running the setpoint ramp

Running a Setpoint Ramp includes starting, holding, viewing the ramp time, ending the ramp and disabling it.

Procedure

Table 5-16 lists the procedure for running the Setpoint Ramp.

Table 5-16 Procedure for Running a Setpoint Ramp

Step	Operation	Press	Action
1	Put the controller into Automatic mode	MANUAL AUTO	until "A" indicator is ON and you will see: Upper Display — H and the PV value Lower Display — SP and the present setpoint value
2	Set Start SP	▲ or ▼	until the start setpoint value you desire is indicated in the lower display: Upper Display — H and the PV value Lower Display — SP and the start setpoint value
3	Start the Ramp	RUN HOLD	You will see: Upper Display — R and the PV value Lower Display — SP and a changing setpoint value NOTE: The value in the lower display will be increasing or decreasing toward the final setpoint value. The PV value in the upper display will also change.
4	Hold the Ramp at the current value	RUN HOLD	This holds the ramp at the current setpoint value. Press again to continue run. A "KEY ERROR" prompt will appear if [RUN/HOLD] key is pressed while "SP RAMP" is disabled.
5	View the remaining ramp time	LOWER DISPLAY	Until you see: Upper Display — R or H and the PV value Lower Display — RAMP XXXM (Time remaining)

Procedure continued on next page

5.9 Single Setpoint Ramp, Continued

Procedure, continued

Table 5-16 Procedure for Running a Setpoint Ramp, continued

Step	Operation	Press	Action
6	End the Ramp		When the final setpoint is reached, the "R" changes to "H" in the upper display and the controller operates at the new setpoint. ATTENTION Anytime the local setpoint is different from the final setpoint value and the RUN/HOLD key is pressed - the ramp will start again.
7	Disable the setpoint ramp function	SET UP	Until you see: Upper Display SET UP Lower Display SP RAMP
		FUNCTION	You will see: Upper Display ENABLE Lower Display SP RAMP
		▲	Until you see: Upper Display DISABL Lower Display SP RAMP
8	Return to normal operating mode	LOWER DISPLAY	

685 749

5.10 Using Two Set of Tuning Constants

Introduction

You can use two set of tuning constants for single output types and choose the way they are to be switched.
The sets can be:
- Keyboard selected
- Automatically switched when a predetermined Process Variable value is reached.
- Automatically switched when a predetermined Setpoint value is reached.

The following procedures show you how to:
- Select two sets
- Set the switch-over value
- Set tuning constant value for each set
- Switch between two sets via the keyboard (without automatic switch-over)

Select two sets

The procedure in Table 5-17 tells you how to select two sets.

Table 5-17 Procedure for Selecting Two Set of Tuning Constants

Step	Operation	Press	Action
1	Select Control Set Up group	SET UP	Until you see: Upper Display SET UP Lower Display CONTROL
2	Select PID SETS function	FUNCTION	Until you see: Upper Display Available selections are listed below Lower Display PIDSETS **1 ONLY** - 1 set of constants **2 KEYBD** - 2 sets, keyboard selectable **2 PVSW** - 2 sets, auto switch at PV value **2 SPSW** - 2 sets, auto switch at SP value
		▲ or ▼	to select the type of PID SET.

Continued on next page

5.10 Using Two Set f Tuning Constants, Continued

Set switch-over value

If you select 2 PVSW or 2 SPSW, you must set a value at which the sets will switch over.
The procedure in Table 5-18 shows you how to set this value.

Table 5-18 Procedure for Setting Switchover Values

Step	Operation	Press	Action
1	Select Switchover value function	FUNCTION assuming you are still in Set Up group "CONTROL"	Until you see: Upper Display [ ] ← The switchover value Lower Display SW VALUE
		▲ or ▼	to select the switch-over value.in the upper display.

Set Tuning constant values for each set

There are specific tuning constant that must be set for each set. The procedure in Table 5-19 shows you how to access these constants and change their values.

Table 5-19 Procedure for Setting Tuning Constant Values

Step	Operation	Press	Action
1	Select Tuning Set Up Group	SET UP	Until you see: Upper Display SET UP Lower Display TUNING
2	Select the tuning constants	FUNCTION	to successively display the following constants: Upper Display [ ] ← The tuning constant value Lower Display [ ] ← **PROP BD or GAIN*** **RATE*** **RSET*** **PROP BD2 or GAIN2**** **RATE 2**** **RSET2****
		▲ or ▼	To change the value of any of the above listed prompts in the lower display.

*PIDSET1 – will be used when PV or SP, whichever is selected, is greater than the switchover value.
**PIDSET2 – will be used when PV or SP, whichever is selected, is less than the switchover value.

Continued on next page

685 751

5.10 Using Two Set of Tuning Constants, Continued

Switch between two sets via the keyboard (without automatic switch-over)

This procedure is operational only if 2 PID SETS was configured at "CONTROL" set up group.

The procedure in Table 5-20 shows you how to switch from one set to another.

Table 5-20 Procedure for switching PID SETS from the Keyboard

Step	Operation	Press	Action
1	Access the PID set display	LOWER DISPLAY	Until you see: Upper Display [ ] ← The PV value Lower Display [PIDSETX] X= 1 or 2
		▲ or ▼	to change PID SET 1 to PID SET 2 or vice versa. You can use Adaptive Tune on each set.

685 752

5.11 Alarm Setpoints

Introduction

An alarm consists of a relay contact and an operator interface indication. The alarm relay is de-energized if Setpoint 1 or Setpoint 2 is exceeded.

The alarm relay is energized when the monitored value goes into the allowed region by more than the hysteresis.

The relay contacts can be wired for normally open (NO)-*energized* or normally closed (NC) de-energized at the rear terminals. See *Section 2 - Installation (Table 2-4)* for alarm relay contact information.

There are four alarm setpoints, two for each alarm.

The type and state (High or Low) is selected during configuration. See *Section 3 - Configuration* for details.

The procedure for displaying and changing the alarm setpoints is listed in Table 5-21.

Procedure for displaying the alarm setpoints

Table 5-21 Procedure for Displaying or Changing the Alarm Setpoints

Step	Operation	Press	Action
1	Access the Alarm Set Up group	SET UP	Until you see: Upper Display SET UP Lower Display ALARMS
2	Access the Alarm Setpoint Values	FUNCTION	to successively display the alarm setpoints and their values. Their order of appearance is shown below. Upper Display [ ] ← The alarm setpoint value Lower Display [ ] **A1S1 VAL** = (Alarm 1, Setpoint 1 value) **A1S2 VAL** = (Alarm 1, Setpoint 2 value) **A2S1 VAL** = (Alarm 2, Setpoint 1 value) **A2S2 VAL** = (Alarm 2, Setpoint 2 value)
		▲ or ▼	to change any alarm setpoint value you select in the upper display.
3	Return to normal operation	LOWER DISPLAY	

685 753

5.12 Three Position Step Control Algorithm

Introduction

The Three Position Step Control algorithm allows the control of a valve (or other actuator) with an electric motor driven by two controller output relays; one to move the motor upscale, the other to move it downscale, without a feedback slidewire linked to the motor shaft. Adaptive Tune does not function with this algorithm

Estimated motor position

The Three Position Step control algorithm provides an output display ("OUT") which is an estimated motor position since the motor is not using any feedback.

Although this output indication is only accurate to a few percent, it is corrected each time the controller drives the motor to one of its stops (0% or 100%).

It avoids all the control problems associated with the feedback slidewire (wear, dirt, noise).

When operating in this algorithm, the estimated "OUT" display is shown to the nearest percent (i.e. no decimal).

Accurate motor position

In the event that an accurate and repeatable indication in motor position is required, Position Proportional model's slidewire input can be used to read the motor position and display it on the lower display as "POS" while still operating in the Three Position Step control mode.
The slidewire must be calibrated for this to operate correctly.

Displaying the motor position

Table 5-22 list the procedure for displaying the motor position.

Table 5-22 Procedure for Displaying the 3PSTEP Motor Position

Step	Operation	Press	Action
1	Access the displays	LOWER DISPLAY	Until you see: Upper Display The PV value Lower Display **POS** = 3PStep motor position with slidewire connected or **OUT** = Estimated 3PStep motor position when no slidewire exists

5.13 Digital Input Option (Remot Switching)

Introduction

The Digital Input option detects the state of external contacts for either of two inputs. On contact closure, the controller will respond according to how each digital input is configured.
Make your selection under Set Up group "OPTION", function group prompt "DIG IN1" or "DIG IN2". See *Section 3 - Configuration* .

Action on closure

Table 5-23 lists the configuration prompt selections, the "Action on Closure", and the display indication for each selection available.

Table 5-23 Digital Input Option Action on Contact Closure

DIG IN1 or DIG IN2 selections	Display Indication	Action on contact closure*
None	DI 1 2 always off*	No Digital Input selection
To MAN	"MAN" blinks	Puts the controller into manual mode Contact open returns the controller to former mode unless AUTO/MAN key is pressed while digital input is active.
To LSP		Puts the controller into local setpoint 1. When contact opens, the controller returns to former operation, local or remote setpoint, unless the SETPOINT/SELECT key is pressed while digital input is active.
To 2SP	"RSP BLOCK" blinks	Puts the controller into local setpoint 2.
To DIR	None	Selects direct controller action.
ToHOLD	"H" blinks	Suspends setpoint program or setpoint ramp. Contact open runs the program or ramp.
ToPID2	PID2 in lower display	Selects PID2
PV 2IN		Selects the PV to equal Input 2.
To RUN	"R" indicator blinks	Starts a stopped SP Program.
ToBEGN		Resets the Setpoint Program back to the beginning of the first segment in the program. The output goes to failsafe, manual mode.
STOP I		Disable PID (I) Integral action.
MANFS		Unit goes to Manual Mode, output goes to the Failsafe value.
To LOCK	"LOCKED" when key pressed	Disables all keys
To A OUT		output goes to value set at control prompt "AUTO OUT"

*The Digital Input Annunciator will always show the Digital Input status.

Keyboard operation

If a particular mode or parameter is selected by the contact closure, using the keyboard to select the same parameter will ensure that the selected mode will be maintained after the remote digital switch is re-opened.

685 755

5.14 Adaptive Tune(Accutune™)

Introduction

Adaptive Tune will continually adjust the Gain or Proportional Band (P), Rate (I), and Reset Time (D) tuning constants in response to setpoint changes.

Adaptive Tune handles all Local and Computer Setpoint changes.

How it works

Adaptive Tune uses time domain analysis, and the rule based expert system techniques to identify the two most dominant process lags plus any dead time.

It then automatically readjusts the PID parameters as necessary. It does this while controlling to setpoint in automatic (closed loop) control mode.

These calculated PID values can be changed, if desired, by disabling Adaptive Tune and entering different values.

Tuning can be aborted by pushing [Manual] key to return to manual mode.

Setpoint changes

During start-up, or whenever the setpoint changes, Adaptive Tune employs time domain analysis to tune the process at any desired setpoint without any prior initialization or process knowledge.

Rules and regulations

The following is a list of rules and regulations for Adaptive Tune.
Adaptive Tune:

- can tune on all Local or Computer setpoints except ramping setpoints
- will work only for algorithms PID-A or PID-B selections, i.e. it will NOT work with ON/OFF or Three Position Step control algorithms.
- is done in automatic mode
- can be monitored or reconfigured over Honeywell's communication network
- can be disabled via Digital Inputs.
- can be aborted by going to manual mode.

Continued on next page

5.14 Adaptive Tune (Accutune™), Continued

Configuration

Before starting Adaptive Tune you must
- enable the Adaptive Tune feature
- set the minimum value of setpoint change in % of span that will result in re-tuning.

Procedure

Use the procedure in Table 5-24 to configure these items.

Table 5-24 Procedure for Configuring Adaptive Tune Parameters

Step	Operation	Press	Action
1	Select Adaptive Tune Set Up Group	SET UP	Until you see: Upper Display SET UP Lower Display ADAPTIVE
2	Select the type of Adaptive Tune	FUNCTION	You will see: Upper Display ← DISABLE, SP ONLY Lower Display ADAPTIVE **DISABLE** - Adaptive Tune disabled **SP ONLY** - Adaptive Tune will occur on setpoint changes only
		▲ or ▼	until the desired selection appears in the upper display.
3	Enter the setpoint change value	FUNCTION	until you see Upper Display ← **Range: ±5 to 15% of PV Span** Lower Display SP CHANG This is the minimum setpoint change value on which re-tuning will occur. Example: If the range is 0 to 2000, and 5% is configured here, re-tuning will occur if the setpoint change is 100 or larger.
		▲ or ▼	until the desired range appears in the upper display.

Table continued on next page

685 757

5.14 Adaptive Tune (Accutune™), Continued

Configuration, continued

Table 5-24 Procedure for Configuring Adaptive Tune Parameters, continued

Step	Operation	Press	Action
4	Verify or change the process Gain value	FUNCTION	You will see: Upper Display [◄] Range: 0.01 to 50.00 Lower Display [KPG] The Process Gain Value is normally a READ only value. It should only be changed if the controller fails to identify the process. In this case, set the value to the algebraic value of PV in percent, divided by output in percent, as displayed while in manual mode.
		▲ or ▼	until the desired range appears in the upper display.

Start-up mode

At start-up, SP ADAPT tuning is used. The procedure for start-up is listed in Table 5-25.

Table 5-25 Procedure for Using Adaptive Tune at Start-up

Step	Operation	Press	Action
1	Put the controller into manual mode	MANUAL AUTO	Until the MAN indicator is ON. You will see: Upper Display [◄] the PV value Lower Display [OUT XXX.X]
		▲ or ▼	to adjust the output value in the lower display, so that the PV lines out at least 10% of PV range and much lower than the normal setpoint setting.
2	Let PV stabilize		Allow the PV to stabilize (stop changing). Depending on the response time of the process, you may have to wait a while for the PV value to line out. Watch the displays for a stable condition.

Table continued on next page

5.14 Adaptive Tune (Accutune™), Continued

Start-up mode, continued

Table 5-25 Procedure for Using Adaptive Tune at Start-up, continued

Step	Operation	Press	Action
3	Adjust the setpoint	LOWER DISPLAY	Until you see: Upper Display [ ] ← the PV value Lower Display [SP XXXX]
		▲ or ▼	to adjust the setpoint value in the lower display to the desired setpoint at which you plan to operate after Adaptive Tune is completed
4	Start SP ADAPT tuning	MANUAL AUTO	The controller will switch to automatic mode and the process will start to move toward the setpoint and will line out with the proper tuning constants. A large "T" appears on the left side of the upper display to indicate that (SP ADAPT) Adaptive tune is in progress. You will see: Upper Display [T XXXX] ← the PV value Lower Display [SP XXXX] ← the setpoint value

SP ADAPT (after Start-up)

SP ADAPT will occur whenever the controller is in automatic mode and a setpoint change occurs which is greater than the previously configured minimum setpoint change value.

The controller will delay using any setpoint changes for 30 seconds to enable it to calculate whether to "SP ADAPT" or not. But, if the controller is toggled between LSP1 and LSP2 or if any other key (such as LOWER/DISPLAY) is pressed, the setpoint change is immediate.

A large "T" is displayed in the upper display whenever SP ADAPT mode is in progress.

Aborting Adaptive Tuning

If it is necessary to stop or abort the tuning, press the [Manual/Auto] key to return to Manual mode. This will cause an immediate abort of tuning.

Also, Adaptive Tune can be temporarily disabled by properly configuring a digital input.

Continued on next page

685.759

Re-Tuning

The controller will evaluate current tuning as SP changes occur. When re-tuning is required, the controller operates in automatic mode controlling to new "intermediate" tuning constants until PV lines out within approximately 0.2% span of SP.

At that point, the "T" disappears and "Final" tuning values are entered and used until re-tuning occurs again. The controller never goes into manual and does not bump the output to evaluate tuning requirements.

Note that if re-tuning was not required, no changes will be made; but, the "T" will still occur to indicate that Adaptive Tune algorithm is measuring the process response.

Error code accessing procedure

When an error is detected in the Adaptive tune process, the message "AT ABORT" will appear in the lower display.

Access function prompt "AT ERROR" to determine what is causing the error. This procedure is listed in Table 5-26.

Table 5-26 Procedure for Accessing Adaptive Tune Error Codes

Step	Operation	Press	Action
1	Select Adaptive Tune Set Up Group	SET UP	Until you see: Upper Display SET UP Lower Display ADAPTIVE
2	Go to Error Code prompt	FUNCTION	You will see: Upper Display An error code Lower Display AT ERROR Table 5-27 lists all the Adaptive tune error codes and their definitions.

Continued on next page

5.14 Adaptive Tune (Accutune™), Continued

Error codes

Table 5-27 lists the Adaptive Tune error codes and their definitions.

Table 5-27 Adaptive Tune Error Code Definitions

Lower Display Prompt	Upper Display Error Code	Code Definition
AT ERROR		**ADAPTIVE TUNE ERROR STATUS** — When an error is detected in the Adaptive Tune process, an error prompt will appear.
	NONE	**NO ERRORS**
	OUTLIM	**OUTPUT GREATER OR LESS THAN OUTPUT LIMITS** - Output set insufficiently to get Setpoint value.
	IDFAIL	**IDENTIFICATION PROCESS FAILED** - An illegal value for Gain, Rate, or Reset was calculated
	ABORT	**CURRENT ADAPTIVE TUNE PROCESS ABORTED** - caused by one of the following conditions: • changing to manual mode • Digital input detected • In heat region of output and a cool output calculated or vice versa.

685 761

Section 6 – Setpoint Ramp/Soak Programming Option

6.1 Overview

What is programming?

The term "programming" is used here to identify the process for selecting and entering the individual ramp and soak segment data needed to generate the required setpoint versus time profile (also called a program).

A segment is a ramp or soak function which together make up a setpoint program. Setpoint Ramp/Soak Programming lets you configure 6 ramp and 6 soak segments to be stored for use as one program or several small programs. You designate the beginning and end segments to determine where the program is to start and stop.

Review program data and configuration

While the procedure for programming is straightforward, and aided by prompts, we suggest that you read *"Program Contents"* in this section as well as *"Section 3 - Configuration"* before doing the setpoint programming.

Fill out the worksheet

Draw a Ramp/Soak Profile on the worksheet provided and fill in the information for each segment. This will give you a record of how the program was developed.

What's in this section

The table below lists the topics that are covered in this section.

6.2 Program Contents

What you will configure

Basically, you will configure all the data that is relevant to each ramp and soak segment for a given setpoint versus time profile. The controller will prompt you through the sequence of segments and associated functions.

Ramp segments

A ramp segment is the time it will take to change the setpoint to the next setpoint value in the program.

Ramps are odd number segments. Segment #1 will be the initial ramp time.

Ramp time is determined in either:

TIME* - Hours:Minutes   Range = 0-99hrs:59 min.

or

RATE* - Degrees/Minute   Range = 0 to 999

* This selection of time or rate is made at prompt "RAMP UNIT"

Set this prompt before entering any Ramp.

ATTENTION Entering "0" will imply an immediate step change in setpoint to the next soak.

Soak segments

A soak segment is a combination of soak setpoint (value) and a soak duration (time).

Soaks are even number segments.

Segment 2 will be the initial soak value and soak time.

The soak setpoint range value must be within the setpoint high and low range limits in engineering units.

SOAK TIME is the duration of the soak and is determined in:

TIME - Hours:Minutes   RANGE = 0-99hrs:59 min.

Start segment number

This designates the number of the first segment.
Range = 1 to 11

End segment number

This designates the number of the last segment. It must be a soak segment (even number).
Range = 2 to 12

Recycle number

This number allows the program to recycle a specified number of times from beginning to end.
Range = 0 to 99

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685 763

6.2 Program Contents, Continued

Guaranteed Soak

Each soak segment can have a deviation value of from 0 to ±99 which guarantees the value for that segment.

Guaranteed soak segment values >0 guarantee that the segments process variable is within the ± deviation for the configured soak time. Whenever the ± deviation is exceeded, soak timing is frozen.

There are no guaranteed soaks whenever the deviation value is configured to 0, i.e., soak segments start timing soak duration as soon as the soak setpoint is first reached, regardless of where the process variable remains relative to the soak segment.

The value is the number in engineering units, above or below the setpoint, outside of which the timer halts. The range is 0 to ± 99.

The decimal location corresponds to input 1 decimal selection.

Program state

This selection determines the program state after completion.

The selections are:

DISABL = Program is disabled

HOLD = Program on hold

Program termination state

This function determines the status of the controller upon completion.

The selections are:

LAST SP = controls to last setpoint and last control mode

F SAFE = Manual mode, Failsafe Output

ATTENTION If power is lost during a program, upon power-up the controller will be in hold and the setpoint value will be the setpoint value prior to the beginning of the setpoint program. The program is placed in hold at the beginning of the first segment in the program.

Ramp unit

This determines the engineering units for the ramp segments.

The selections are:

TIME = Hours:Minutes

RATE = Degrees/Minutes

ATTENTION This selection cannot be changed while a program is in operation.

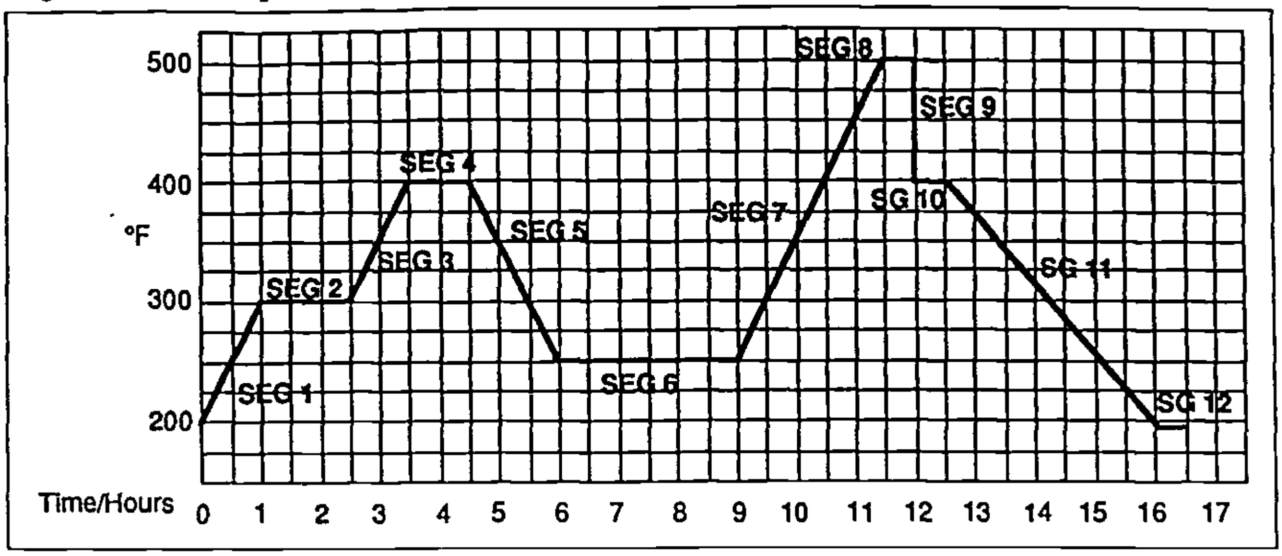
685 764

6.3 Drawing a Ramp/Soak Profile

Ramp/Soak Profile example

Before you do the actual configuration, we recommend that you draw a Ramp/Soak profile in the space provided on the "*Program Record Sheet*" (Figure 6-2) and fill in the associated information.
An example of a Ramp/Soak Profile is shown in figure 6-1.

Figure 6-1 Ramp/Soak Profile Example



Prompt	Function	Segment	Value	Prompt	Function	Segment	Valu
STRT SEG	Start Seg.		1	SEG7RAMP	Ramp Time	7	2hrs:3
END SEG	End Seg.		12	SEG8 SP	Soak SP	8	50
RECYCLES	Number of Recycles		2	SEG8TIME	Soak Time	8	0hr.:30
SOAK DEV	Deviation Value		0	SEG9RAMP	Ramp Time	9	0
SEG1RAMP	Ramp Time	1	1 hr.	SG10 SP	Soak SP	10	40
SEG2 SP	Soak SP	2	300	SG10 TIME	Soak Time	10	0hr.:30
SEG2TIME	Soak Time	2	1hr.:30 min.	SG11RAMP	Ramp Time	11	3hrs:3
SEG3RAMP	Ramp Time	3	1hr.	SG12 SP	Soak SP	12	20
SEG4 SP	Soak SP	4	400	SG12TIME	Soak Time	12	0hr.:30
SEG4TIME	Soak Time	4	1 hr.	STATE	Controller State at end		HO
SEG5RAMP	Ramp Time	5	1hr.:30 min.	PROG END	Controller Status		LAST
SEG6 SP	Soak SP	6	250	RAMP UNIT	Engr. Unit for Ramp		TI
SEG6TIME	Soak Time	6	3hrs.:0min.				

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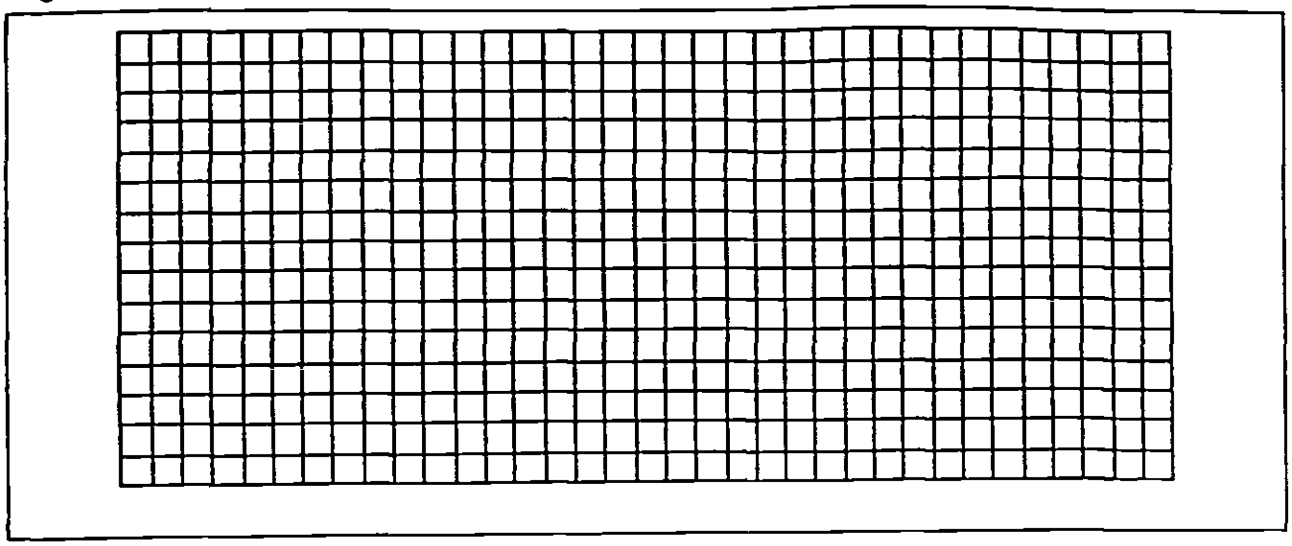
685 765

6.3 Drawing a Ramp/Soak Profile, Continued

Program Record Sheet Draw your ramp/soak profile on the record sheet shown in Figure 6-2 and fill in the associated information in the blocks provided. This will give you a permanent record of your program and will assist you when entering the Setpoint data.

Figure 6-2 Program Record Sheet



Prompt	Function	Segment	Value
STRT SEG	Start Seg.		
END SEG	End Seg.		
RECYCLES	Number of Recycles		
SOAK DEV	Deviation Value		
SEG1RAMP	Ramp Time	1	
SEG2 SP	Soak SP	2	
SEG2TIME	Soak Time	2	
SEG3RAMP	Ramp Time	3	
SEG4 SP	Soak SP	4	
SEG4TIME	Soak Time	4	
SEG5RAMP	Ramp Time	5	
SEG6 SP	Soak SP	6	
SEG6TIME	Soak Time	6	

Prompt	Function	Segment	Value
SEG7RAMP	Ramp Time	7	
SEG8 SP	Soak SP	8	
SEG8TIME	Soak Time	8	
SEG9RAMP	Ramp Time	9	
SG10 SP	Soak SP	10	
SG10 TIME	Soak Time	10	
SG11RAMP	Ramp Time	11	
SG12 SP	Soak SP	12	
SG12TIME	Soak Time	12	
STATE	Program Controller State		
PROG END	Controller Status		
RAMP UNIT	Engr. Unit for Ramp		

6.4 Entering the Setpoint Program Data

Introduction

The procedure listed in table 6-1 tells you what keys to press and what prompts you will see when entering the setpoint program data. Follow the prompt hierarchy listed in table 6-2 when selecting the functions for setpoint programming.

ATTENTION Make sure SP RAMP and SP RATE are disabled first.

Table 6-1 Setpoint Program Data Entry Procedure

Step	Action	Press	Result
1	Select SP PROG Group	SET UP until you see	Upper Display SET UP Lower Display SP PROG
2	Select the functions	FUNCTION	This accesses the function prompts and enables Setpoint Programming. Upper Display The current value for each prompt is shown Lower Display The individual function prompts within the setpoint program group are shown. *Successive* presses of the [FUNCTION] key will sequentially display all the functions and their values or selections. Follow the prompt hierarchy shown in table 6-2.
3	Change the value or selection of a function prompt	▲ or ▼	This changes the value or selection in the upper display. If the display blinks, you are trying to select an unacceptable value.
4	Enter Value or selection into memory	FUNCTION	This enters the value or selection and goes to another prompt. Repeat steps 3 and 4 for each function you want to change.
5	Exit configuration	LOWER DISPLAY	This exits from the configuration mode.

Alarms on the Setpoint Program

You can configure an event to go ON or OFF at the beginning or end of any segment. Refer to *Section 3 - Configuration* under *"Alarms Parameters Group"* for details.

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685 767

6.4 Entering th Setpoint Pr gram Data, Continued

Prompt Hierarchy

Table 6-2 lists all the function prompts for Setpoint Program data configuration in the order of their appearance.

Follow the procedure in table 6-1 to transfer the data from your setpoint Ramp/Soak profile into the controller.

All parameters may be changed while the program is disabled or in HOLD.

Table 6-2 Prompt Hierarchy and Available Selections

Prompt	Definition	Value or Selection (use ▲ or ▼)
SP RAMP	Setpoint Ramp selection	*Selections*: DISABLE **SP RAMP must be disabled to allow Setpoint Programming.**
SP RATE	Setpoint Rate of Change	*Selections*: DISABLE **SP RATE must be disabled to allow Setpoint Programming.**
SP PROG	Setpoint Ramp/Soak Programming	*Selections*: ENABLE DISABLE **SP PROG must be enabled to view the remaining prompts.**
STRT SEG	Start Segment Number	*Enter Value*: 1 to 11
END SEG	End Segment Number	*Enter Value*: 2 to 12 Always end in a soak Segment (2,4,.....12)
RECYCLES	Number of Program Recycles	*Enter Value*: 0 to 99 recycles
soak dev	Guaranteed Soak Deviation Value	*Enter Value*: 0 to ± 99 The number selected will be 0 to 99± from setpoint.
Seg1ramp or SEg1rate	Segment #1 Ramp Time Segment #1 Ramp Rate	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or Ramp Rate = 0-999 degrees/min **Select HRS:MIN or DEG/MIN at prompt "RAMP UNIT".** **All ramps will use the same selection.**
Seg2 SP	Segment #2 Soak Setpoint Value	*Enter Value*: Within the Setpoint limits
seg2time	Segment #2 Soak Duration	*Enter Value*: 0-99hrs:0-59min
Seg3ramp or SEg3rate	Segment #3 Ramp Time Segment #3 Ramp Rate	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or Ramp Rate = 0-999 degrees/min
Seg4 SP	Segment #4 Soak Setpoint Value	*Enter Value*: Within the Setpoint limits
seg4time	Segment #4 Soak Duration	*Enter Value*: 0-99hrs:0-59min

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6.4 Entering the Setpoint Program Data, continued

Prompt Hierarchy (continued)

Table 6-2 Prompt Hierarchy and Available Selections, continued

Prompt	Definition	Value or Selection (use ▲ or ▼)	
Seg5ramp or SEg5rate	Segment #5 Ramp Time Segment #5 Ramp Rate	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or Ramp Rate = 0-999 degrees/min	
Seg6 SP	Segment #6 Soak Setpoint Value	*Enter Value*:	Within the Setpoint limits
seg6time	Segment #6 Soak Duration	*Enter Value*:	0-99hrs:0-59min
Seg7ramp or SEg7rate	Segment #7 Ramp Time Segment #7 Ramp Rate	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or Ramp Rate = 0-999 degrees/min	
Seg8 SP	Segment #8 Soak Setpoint Value	*Enter Value*:	Within the Setpoint limits.
seg8time	Segment #8 Soak Duration	*Enter Value*:	0-99hrs:0-59min
Seg9ramp or SEg9rate	Segment #9 Ramp Time Segment #9 Ramp Rate	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or Ramp Rate = 0-999 degrees/min	
Sg10 SP	Segment #10 Soak Setpoint Value	*Enter Value*:	Within the Setpoint limits
sg10time	Segment #10 Soak Duration	*Enter Value*:	0-99hrs:0-59min
Sg11ramp or Sg11rate	Segment #11 Ramp Time Segment #11 Ramp Rate	*Enter Value*: Ramp Time = 0-99hrs:0-59min, or Ramp Rate = 0-999 degrees/min	
Sg12 SP	Segment #12 Soak Setpoint Value	*Enter Value*:	Within the Setpoint limits
sg12time	Segment #12 Soak Duration	*Enter Value*:	0-99hrs:0-59min
STATE	Program state at program end	*Selections:*	DISABLE HOLD(hold mode)
PROG END	Program Termination State	*Selections:*	LAST SP - Hold at last setpoint in the program F SAFE - Manual mode/Failsafe output
RAMPUNIT	Engineering units for ramp segments	*Selections:*	TIME RATE

685 769

6.5 Run/Monitor the Program

Introduction

Make sure all the "SP PROG" function prompts under the Set Up group "SP RAMP" have been configured with the required data.
An "H" will appear in the upper display indicating that the program is in the HOLD state.

Run/Monitor functions

Table 6-3 lists all the functions required to run and monitor the program.

Table 6-3 Run/Monitor Functions

Function	Press	Result
Set the Local Setpoint	SETPOINT SELECT	You will see Upper Display: Local Setpoint Value Lower Display: SP
	▲ or ▼	To set the Local Setpoint value to where you want the program to start out.
Run State	RUN HOLD	Initiates the setpoint program. An "R" appears in the upper display indicating that the program is running.
Hold State	RUN HOLD	Holds the setpoint program. An "H" appears in the upper display indicating that the program is in the HOLD state. The setpoint holds at the current setpoint.
External Hold		If Remote Switching (Digital Input Option) is present on your controller, contact closure places the controller in the HOLD state, if the setpoint program is running. The "H" in the upper display will blink. ATTENTION The keyboard takes priority over external switch for the RUN/HOLD function. Contact reopening runs program.
Changing a Segment while in Hold	▲ or ▼	These keys will operate and allow you to change the segment number while in HOLD. If a different segment is selected, it will be started at the beginning when placed in RUN. If the original segment is brought back, it will continue from the point placed in HOLD. NOTE: changing a segment number may affect the alarms/events.

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685 770

Run/Monitor functions (continued)

Table 6-3 Run/Monitor Functions, continued

Function	Press	Result
External Program Reset		If Remote Switching (Digital Input Option) is present on your controller, contact closure resets the SP Program back to the start of the first segment. Program cycle number is not affected. Reopening the contact has no effect.
	RUN HOLD	restarts the Setpoint Program
Viewing the present ramp or soak segment number and time	LOWER DISPLAY until you see	Upper Display "R" and the PV value Lower Display For Ramp segments: #RA XX.XX Ramp Time - Hours:Minutes or Ramp Rate - Degrees/Minute Indicates Ramp segment Segment Number (odd only) For Soak segments: #SK XX.XX Time remaining in segment in Hrs:Minutes including current partially completed minute Indicates Soak segment Segment Number (even only)
Viewing the number of cycles left in the program	LOWER DISPLAY until you see	Upper Display "R" and the PV value Lower Display RECYC XX Remaining Cycles 0 to 99 This number includes the current partially completed cycle.

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6.5 Run/Monitor the Program, Continued

Run/Monitor functions (continued)

Table 6-3 Run/Monitor Functions, continued

Function	Press	Result
End Program		When the final segment is completed, the "R" in the upper display either changes to "H" if contigured for HOLD state, or disappears if configured for disable of setpoint programming. The controller operates at the last setpoint in the program in automatic or will be in manual mode at the failsafe output.

Power-up state

The program will be placed in HOLD mode at the beginning of the program at the local Setpoint value prior to the beginning of the program.

685 772

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685 773

Section 7 – Input Calibration

7.1 Overview

Introduction

This section describes the field calibration procedures for Input 1 and Input 2.
Every UDC3000 controller contains all input actuation ranges fully factory calibrated and ready for configuration to range by the user.
However these procedures can be implemented if the factory calibration of the desired range is not within specifications.
Note that the field calibration will be lost if a change in input type configuration is implemented at a later time. The original factory calibration data remains available for later use after a field calibration is done.

What's in this section

This section contains the following topics:

Calibration steps

Use the following steps when calibrating an input.

Step	Action
1	Find the minimum and maximum range values for your PV input range from Table 7-1.
2	Disconnect the field wiring and find out what equipment you will need to calibrate. DO NOT remove external resistor assemblies (if present).
3	Wire the calibrating device to your controller according to the Set Up wiring instructions for your particular input.
4	Follow the calibration procedure given for Input #1 or Input #2.

7.2 Minimum and Maximum Range Values

Select the range values

You should calibrate the controller for the minimum (0%) and Maximum (100%) range values of your particular sensor.
If you have a two input controller, calibrate each input separately.
Select the Voltage or Resistance equivalent for 0% and 100% range values from Table 7-1. Use these value when calibrating your controller.

Table 7-1 Voltage and Resistance Equivalents for 0% and 100% Range Values

Sensor Type	PV Input Range		Range Values	
	°F	°C	0%	100%
B Thermocouple	0 to 3300	–18 to 1815	–0.010 mV	13.763 mV
E Thermocouple	-454 to 1832	–270 to 1000	–9.835 mV	76.358 mV
E (low) Thermocouple	-200 to 1100	–129 to 593	–6.471 mV	44.547 mV
J Thermocouple	0 to 1600	–18 to 871	–0.885 mV	50.059 mV
J (low) Thermocouple	20 to 770	–7 to 410	–0.334 mV	22.397 mV
K Thermocouple	0 to 2400	–18 to 1316	–0.692 mV	52.939 mV
K (low) Thermocouple	–20 to 1000	–29 to 538	–1.114 mV	22.251 mV
NiNiMoly T/C	32 to 2500	0 to 1371	–0.001 mV	71.330 mV
NiNiMoly (low) T/C	32 to 1260	0 to 682	–0.001 mV	31.820 mV
Nicrosil Nisil T/C	0 to 2372	–18 to 1300	–0.461 mV	47.502 mV
R Thermocouple	0 to 3100	–18 to 1704	–0.089 mV	20.275 mV
S Thermocouple	0 to 3100	–18 to 1704	–0.092 mV	17.993 mV
T Thermocouple	-300 to 700	–184 to 371	–5.341 mV	19.095 mV
T (low) Thermocouple	-200 to 500	–129 to 260	–4.149 mV	12.572 mV
W5W26 T/C	0 to 4200	–18 to 2316	–0.234 mV	37.066 mV
W5W26 (low) T/C	0 to 2240	–18 to 1227	–0.234 mV	22.277 mV
RTD (IEC=0.00385) 100 Ohms 100 Ohms (low) 500 Ohms	 -300 to 1200 0 to 300 -300 to 1200	 –184 to 649 –18 to 149 –184 to 649	 25.18 Ω 93.03 Ω 125.90 Ω	 329.16 Ω 156.90 Ω 1645.80 Ω
Radiamatic (RH)	1400 to 3400	760 to 1871	0.99 mV	57.12 mV
Milliamps	4 to 20 mA		4 mA	20 mA
Millivolts	0 to 10 mV		0 mV	10 mV
	10 to 50 mV		10 mV	50 mV
Volts	1 to 5 Volts		1 Volt	5 Volts
	0 to 10 Volts		0 Volts	10 Volts

685 775

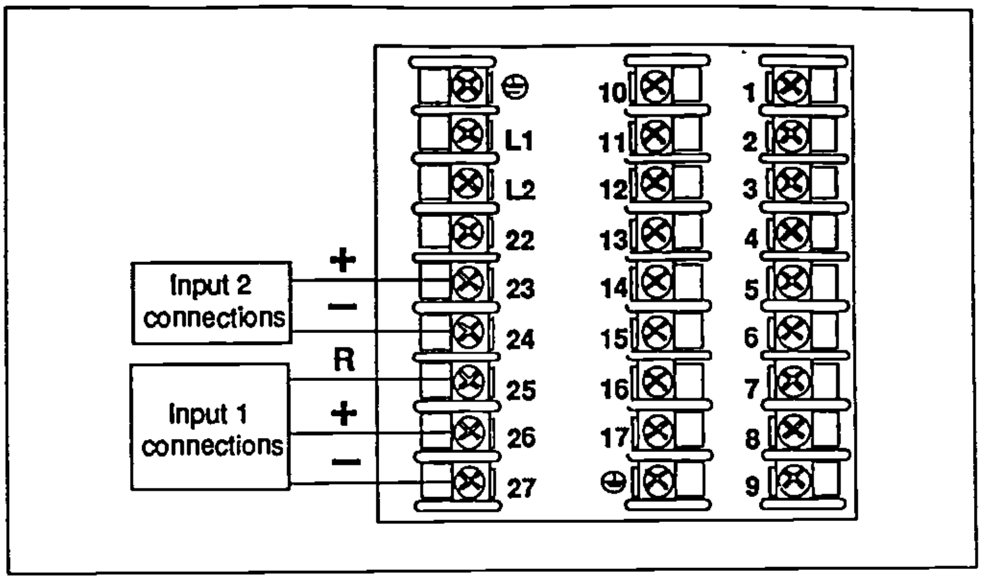
7.3 Preliminary Information

Disconnect the field wiring

Depending on which input (#1 or #2) you are going to calibrate, tag and disconnect any field wiring connected to the input terminals on the rear of the controller.

Figure 7-1 shows the wiring terminal designations for Input #1 and Input #2.

Figure 7-1 Input #1 and #2 Wiring Terminals



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7.3 Preliminary Information, Continued

Equipment needed

Table 7-2 lists the equipment you will need to calibrate the specific types of inputs that are listed in the table. You will need a screwdriver to connect these devices to your controller.

Table 7-2 Equipment Needed

Type of Input	Equipment Needed
Thermocouple Inputs (Ice Bath)	• A calibrating device with ±0.02% accuracy for use as a signal source such as a millivolt source. • Thermocouple extension wire that corresponds with the type of thermocouple that will be used with the controller input. • Two insulated copper leads for connecting the thermocouple extension wire from the ice baths to the precision calibrator. • Two containers of crushed ice.
Thermocouple Inputs (Precision Resistor)	• A calibrating device with ±0.02% accuracy for use as a signal source such as a millivolt source. • Two insulated copper leads for connecting the calibrator to the controller. • A precision 500 ohm resistor ±0.1% connected across input #1 terminals 25(R) and 27(–).
RTD (Resistance Thermometer Device)	• A decade box, with ±0.02% accuracy, capable of providing stepped resistance values over a minimum range of 0 to 1400 Ohms with a resolution of 0.1 ohm. • Three insulated copper leads for connecting the decade box to the controller.
Milliampere, Millivolt, Volts, and Radiamatic	• A calibrating device with ±0.02% accuracy for use as a signal source. • Two insulated copper leads for connecting the calibrator to the controller. • Place current source at zero before switching ON. • Do not switch current sources OFF/ON while connected to the UDC3000 input.

685 777

7.4 Input #1 Set Up Wiring

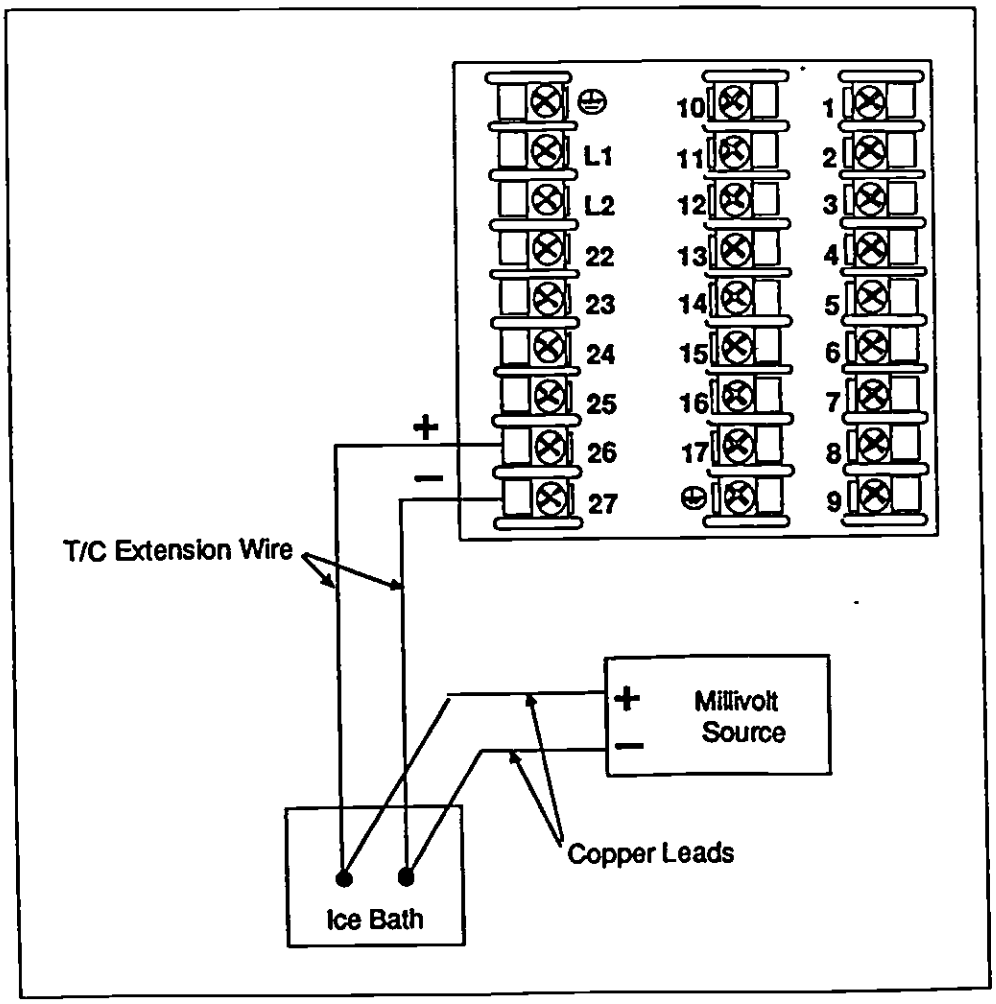
Thermocouple Inputs using an Ice bath

Refer to Figure 7-2 and wire the controller according to the procedure given in Table 7-3.

Table 7-3 Set Up Wiring Procedure for Thermocouple Inputs Using An Ice Bath

Step	Action
1	Connect the copper leads to the calibrator.
2	Connect a length of thermocouple extension wire to the end of each copper lead and insert the junction points into the ice bath.
3	Connect the thermocouple extension wires to the terminals for Input #1. See Figure 7-2.

Figure 7-2 Wiring Connections for Thermocouple Inputs Using an Ice Bath



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7.4 Input #1 Set Up Wiring, Continued

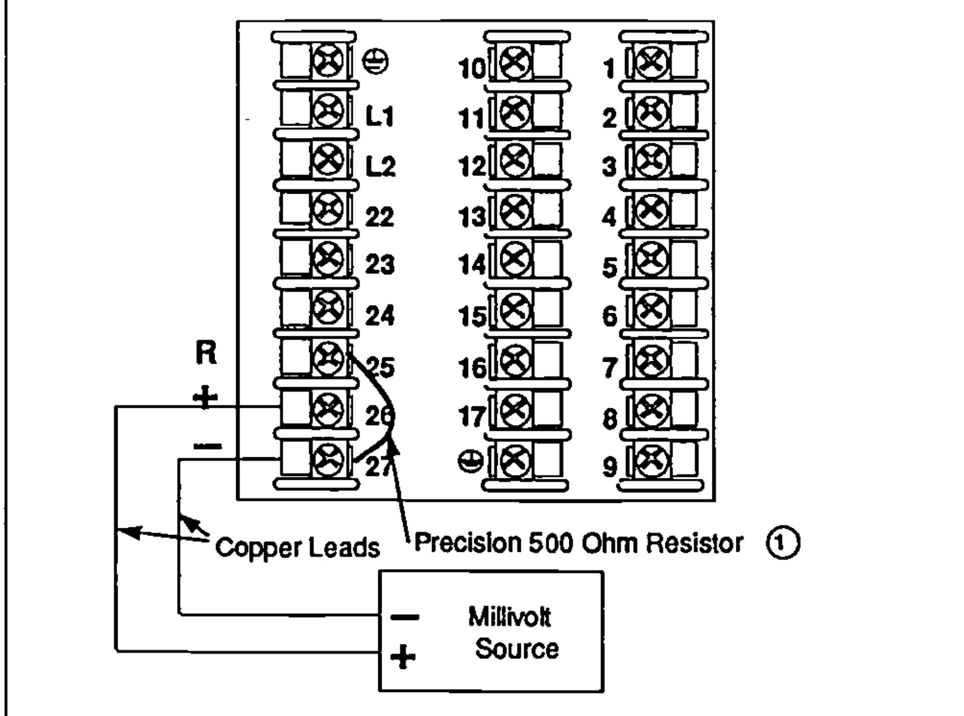
Thermocouple inputs using a precision resistor

Refer to Figure 7-3 and wire the controller according to the procedure given in table 7-4.

Table 7-4 Set Up Wiring Procedure for Thermocouple Inputs Using a Precision Resistor

Step	Action
1	Connect the copper leads to the calibrator.
2	Disconnect the cold junction resistor.
3	Install a 500 Ohm precision resistor across terminal 25(R) and terminal 27(—). See figure 7-3.
4	Subtract the millivolt value for 77°F (25°C) from the zero and span value for your range (see Table 7-1 for zero and span values) and use the adjusted value when calibrating.

Figure 7-3 Wiring Connections for Thermocouple Inputs Using a Precision Resistor



① **Warning:** The accuracy of the controller is directly affected by the accuracy of this resistor. At a minimum, use a 0.1%, 25ppm resistor

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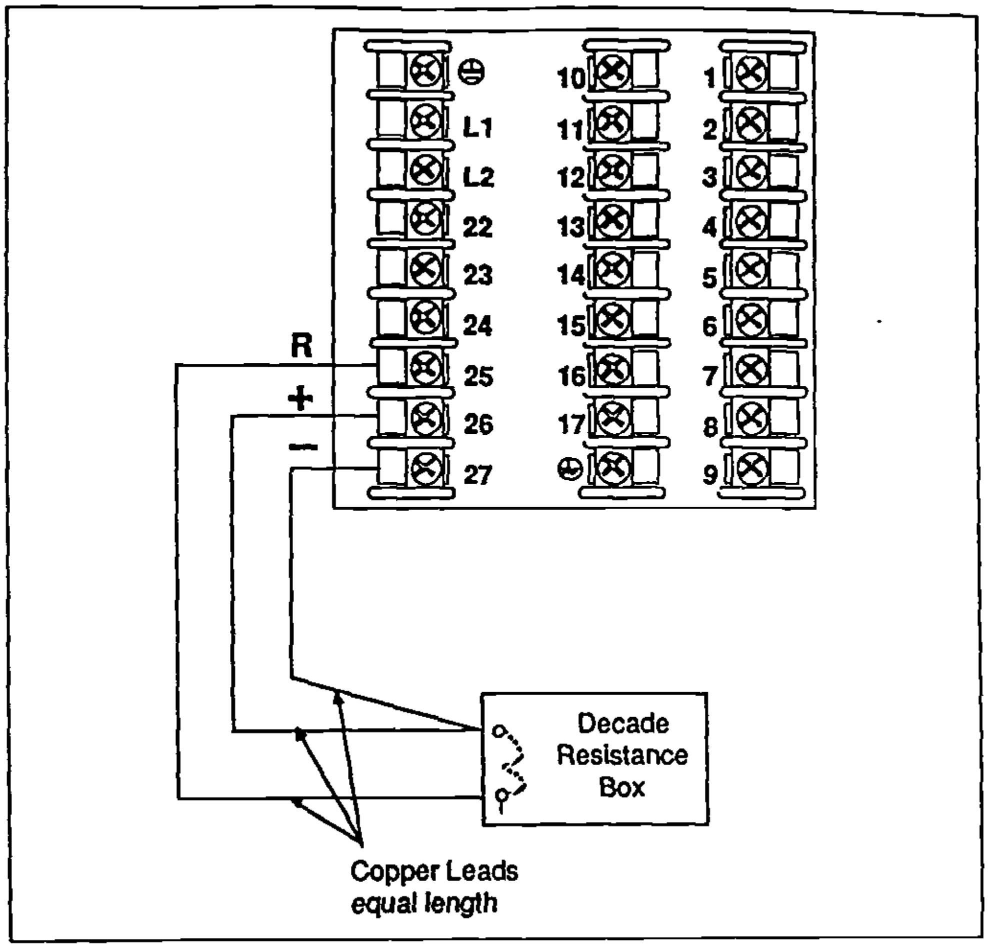
685 779

7.4 Input #1 Set Up Wiring, Continued

RTD Inputs

Use the copper leads and connect the calibrator to the rear terminals of Input #1. See Figure 7-4.

Figure 7-4 Wiring Connections for RTD (Resistance Thermometer Device)



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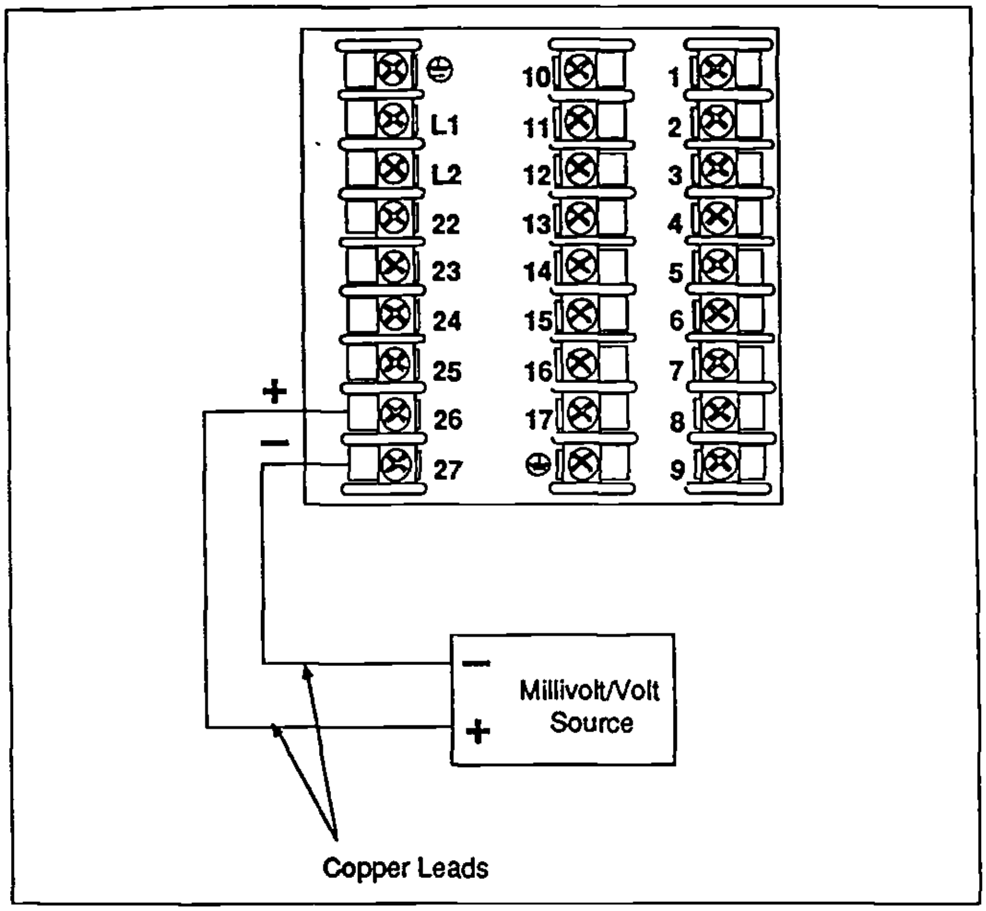
7.4 Input #1 Set Up Wiring, Continued

Radiamatic, Millivolts, or Volts (except 0 to 10 Volts) Inputs

Use the copper leads and connect the calibrator to the rear terminals of Input #1. See Figure 7-5.

Figure 7-5 Wiring Connections for Radiamatic, Millivolts, or Volts (except 0 to 10 Volts)



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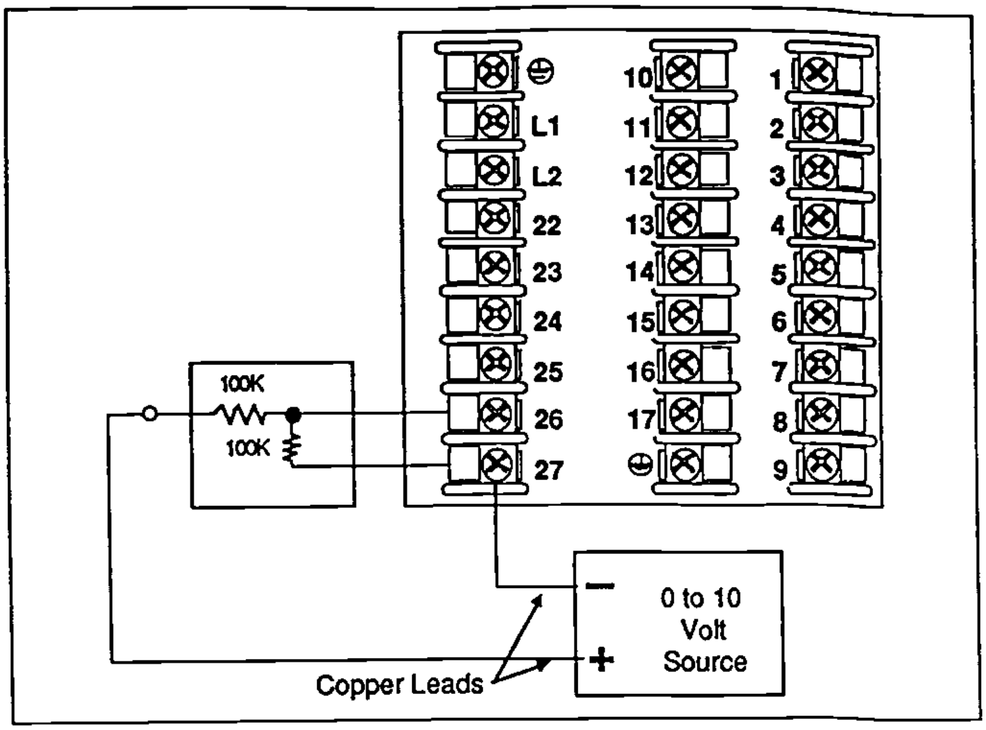
685 781

7.4 Input #1 Set Up Wiring, Continued

0 to 10 Volt Inputs

Use the copper leads and connect the calibrator to the rear terminals of Input #1. See Figure 7-6.

Figure 7-6 Wiring Connections for 0 to 10 Volt inputs



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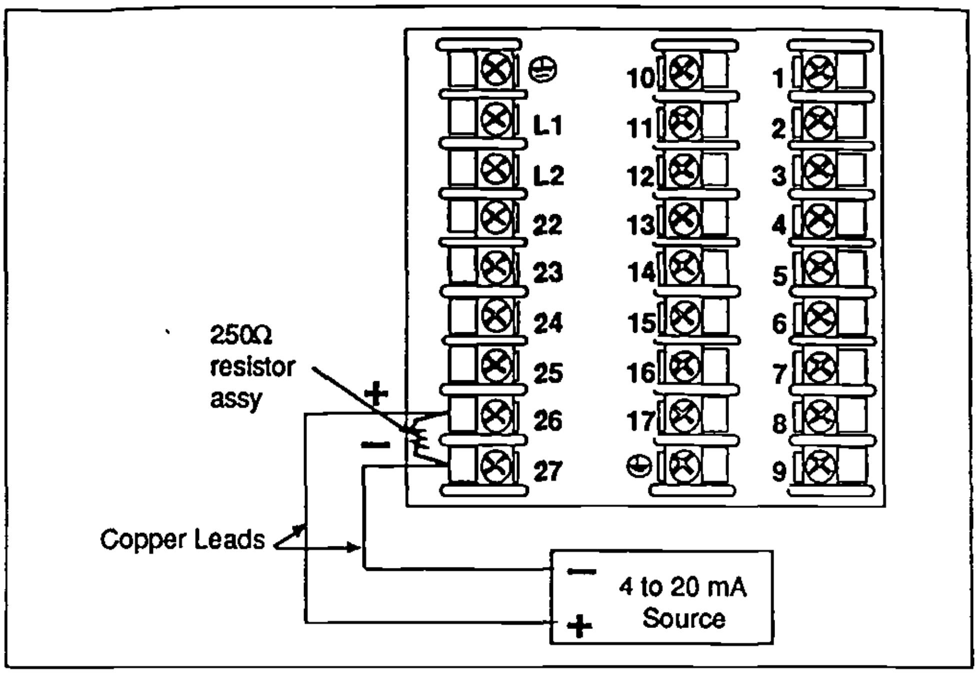
7.4 Input #1 Set Up Wiring, Continued

4 to 20 mA Inputs

Use the copper leads and connect the calibrator to the rear terminals of Input #1. See Figure 7-7.

Figure 7-7 Wiring Connections for 4 to 20 mA inputs



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7.5 Input #1 Calibration Procedur

Introduction

Apply power and allow the controller to warm up for 15 minutes before you calibrate.
Please read "*Set Up Wiring*" before beginning the procedure.
Make sure you have "LOCKOUT" set to "NONE." See *Section 3 – Configuration.*

CAUTION For linear inputs, avoid step changes in inputs. Vary smoothly from initial value to final 100% value.

Procedure

The Calibration procedure for Input #1 is listed in table 7-5.

Table 7-5 Input #1 Calibration Procedure

Step	Description	Press	Action
1	Enter Calibration Mode	SET UP until you see	Upper Display: CALIB Lower Display: INPUT 1
		FUNCTION	You will see: Upper Display: DISABL Lower Display: CAL IN1
		▲	The calibration sequence is enabled and you will see: Upper Display: BEGIN Lower Display: CAL IN1 At the completion of the sequence, the selection automatically reverts to disable.
2	Calibrate 0%	FUNCTION	You will see: Upper Display: APPLY Lower Display: IN1 ZERO Adjust your calibration device to an output signal equal to the 0% range value for your particular input sensor. See Table 7-1 for Voltage or Resistance equivalents. Wait 30 seconds, then go to the next step.

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7.5 Input #1 Calibration Procedure, Continued

Table 7-5 Input #1 Calibration Procedure, continued

Step	Description	Press	Action
3	Calibrate 100 %	FUNCTION	You will see: Upper Display APPLY Lower Display IN1 SPAN Adjust your calibration device to an output signal equal to the 100% range value for your particular input sensor. See Table 7-1 for Voltage or Resistance equivalents. Wait 30 seconds, and **If...** → **Then...** you are calibrating a Thermocouple input → Go to step 4 you are calibrating other than a Thermocouple input → Go to step 5
4	Check the Cold Junction Temperature **WARNING** The accuracy of the controller is directly affected by the accuracy of this value. Change this value only if the zero and span calibration procedures did not bring the controller within the specified accuracy requirements.	FUNCTION	The calculations for zero and span are now stored and you will see: Upper Display [ ] ← The cold junction temperature at the rear terminals Lower Display C-J TEMP The value in the upper display is in the tenths of a degree. It is the current reading of the temperature as measured at the thermocouple terminals and recognized by the controller. You can change this value, if it is in error, using the ▲ or ▼ key. **ATTENTION** When calibrating T/C inputs using a precision resistor, calibrate the cold junction as 77°F (25°C).
5	Exit the Calibration Mode	FUNCTION	The controller will store the calibration constants and exit calibration mode.

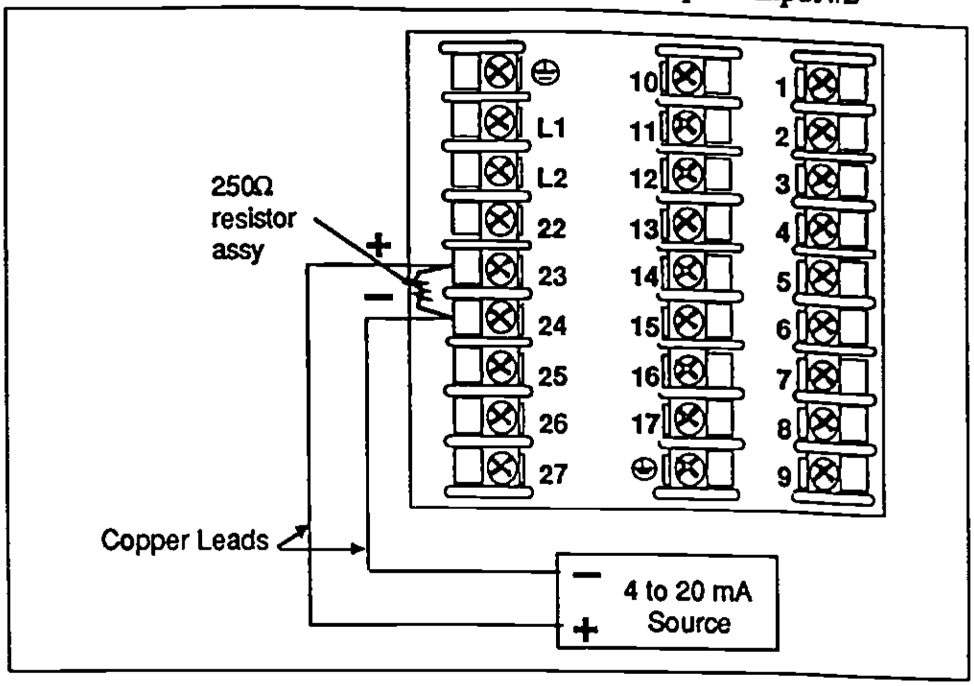
685 785

7.6 Input #2 Set Up Wiring

4 to 20 mA Input

Use the copper leads and connect the calibrator to the rear terminals of Input #2. See Figure 7-8.

Figure 7-8 Wiring Connections for 4 to 20 mA input – Input #2



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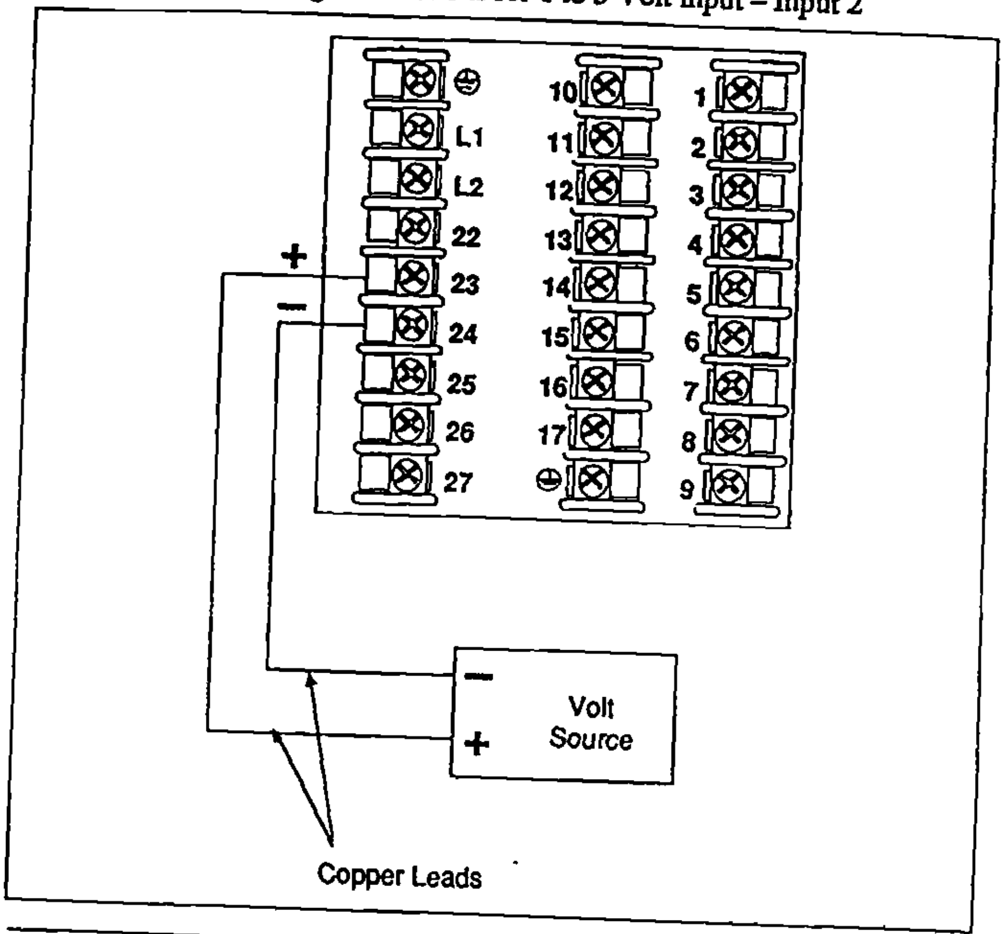
7.6 Input #2 Set Up Wiring, Continued

1 to 5 Volt Inputs

Use the copper leads and connect the calibrator to the rear terminals of Input #2. See Figure 7-9.

Figure 7-9 Wiring Connections for 1 to 5 Volt input – Input 2



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7.7 Input #2 Calibration Procedure

Introduction

Apply power and allow the controller to warm up for 15 minutes before you calibrate.
Please read *"Set Up Wiring"* before beginning the procedure.
Make sure you have "LOCKOUT" set to "NONE." See *Section 3 – Configuration.*

Procedure

The Calibration procedure for Input #2 is listed in table 7-6.

Table 7-6 Input #2 Calibration Procedure

Step	Description	Press	Action
1	Enter Calibration Mode	SET UP until you see	Upper Display: CALIB Lower Display: INPUT 2
		FUNCTION	You will see: Upper Display: DISABL Lower Display: CAL IN2
		▲	You will see: Upper Display: BEGIN Lower Display: CAL IN2
2	Calibrate 0%	FUNCTION	You will see Upper Display: APPLY Lower Display: IN2 ZERO Adjust your calibration device to an output signal equal to the 0% range value for your particular input sensor. See Table 7-1 for Voltage or Resistance equivalents. Wait 30 seconds, then go to the next step.

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7.7 Input #2 Calibration Procedure, Continued

Table 7-6 Input #2 Calibration Procedure, continued

Step	Description	Press	Action
3	Calibrate 100 %	FUNCTION	You will see Upper Display APPLY Lower Display IN2 SPAN Adjust your calibration device to an output signal equal to the 100% range value for your particular input sensor. See Table 7-1 for Voltage or Resistance equivalents. Wait 30 seconds, then go to the next step.
4	Exit the Calibration Mode	FUNCTION	The controller will store the calibration constants.
		LOWER DISPLAY or SET UP	To store the calibration constants and exit the calibration mode.

685 789

Section 8 – Output Calibrati n

8.1 Overview

Introduction

This section describes the field calibration procedures for the following types of outputs:

- Current Output
- Position Proportional and 3 Position Step Output
- Auxiliary Output

What's in this section

This section contains the following topics:

8.2 Current Proportional Output Calibration

Introduction

Calibrate the controller so that the output provides the proper amount of current over the desired range.
The controller can provide an output current range of from 0 to 21 milliamperes and can be calibrated at 4 mA for 0% of output and 20 mA for 100% of output or any other values between 0 and 21 mA.

Equipment needed

You will need a standard shop type milliammeter, with whatever accuracy is required, capable of measuring 0 to 20 milliamps.

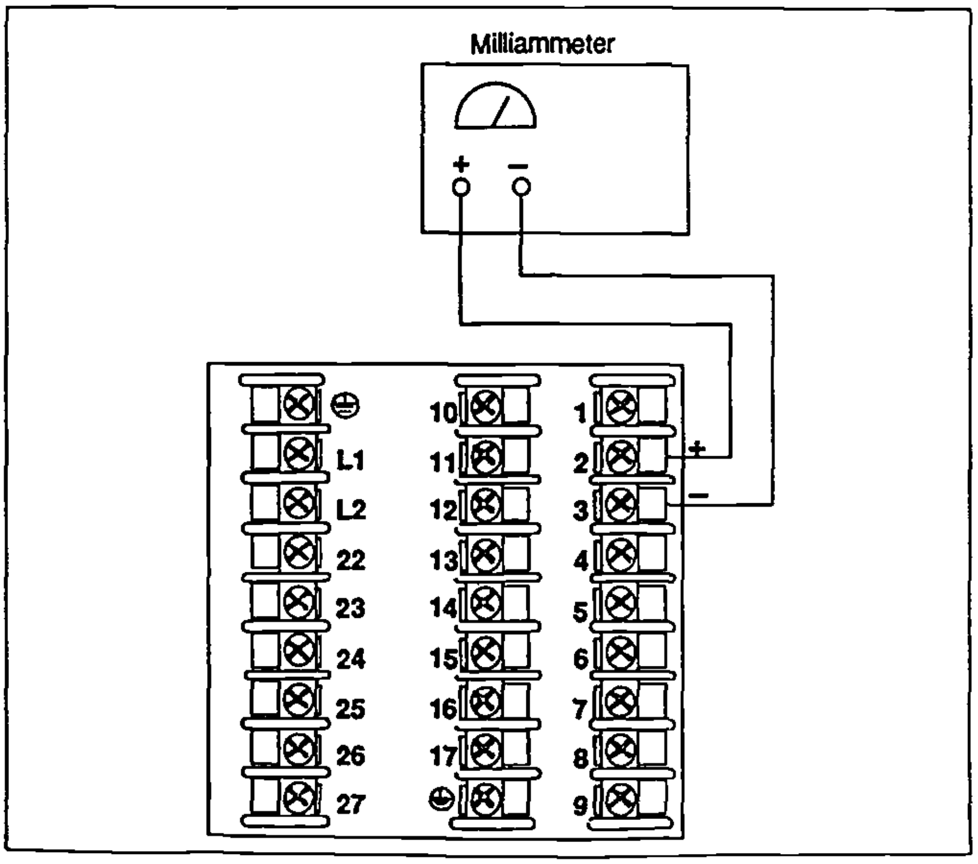
Calibrator connections

Refer to Figure 8-1 and wire the controller according to the procedure given in table 8-1.

Table 8-1 Set Up Wiring Procedure Current Proportional Output

Step	Action
1	Apply power and allow the controller to warm up 15 minutes before you calibrate.
2	Tag and disconnect the field wiring, at the rear of the controller, from terminals 2(+) and 3(–). See Figure 8-1.
3	Connect a Milliammeter across these terminals.

Figure 8-1 Wiring Connections for Calibrating Current Proportional Output



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8.2 Current Proporti nal Output, Continued

Procedure

The procedure for calibrating the Current Proportional Output is listed in table 8-2. Make sure "LOCKOUT" in the Tuning Set Up group is set to "NONE." See *Section 3 – Configuration.*

Table 8-2 Current Proportional Output Calibration Procedure

Step	Description	Press	Action
1	Enter Calibration Mode	SET UP until you see	Upper Display: CALIB Lower Display: CURRENT
2	Calibrate 0%	FUNCTION	You will see: Upper Display: a value between 1 and 2048 Lower Display: ZERO VAL
		▲ or ▼	until the desired 0% output is read on the milliammeter. Use the values shown below depending on the action of your controller. 0 mA For 0 to 20 mA Direct Action* 20 mA For 0 to 20 mA Reverse Action 4 mA For 4 to 20 mA Direct Action 20 mA For 4 to 20 mA Reverse Action
3	Calibrate 100%	FUNCTION	This stores the 0%value and, You will see: Upper Display: a value between 1 and 2048 Lower Display: SPAN VAL
		▲ or ▼	until the desired 100% output is read on the milliammeter. Use the values shown below depending on the action of your controller. 20 mA For 0 to 20 mA Direct Action 0 mA For 0 to 20 mA Reverse Action* 20 mA For 4 to 20 mA Direct Action 4 mA For 4 to 20 mA Reverse Action
4	Exit the Calibration Mode	FUNCTION	The controller will store the span value.
		LOWER DISPLAY or SET UP	To exit the calibration mode. * When attempting to achieve 0 mA, always adjust the output to about 0.5 mA, and slowly decrease until the output just goes to zero. Further decrementing will not change the output current (since the circuit cannot produce negative current) but will affect the accuracy of the output by creating a dead zone where no current flows.

8.3 Position Proportional and Three Position Step Output Calibration

Position Proportional control

When the UDC 3000 controller has a Position Proportional control output, calibrate the controller so that the increase and decrease relays operate properly with respect to the position of the external feedback slidewire.

3 Position Step control

Three Position Step Control Output models with Motor Position Indication
This model must have its output calibrated per the entire procedure to ensure the displayed output (slidewire position) agrees with the final control element position.
Three Position Step Control Output models without Motor Position Indication
This model only requires that the "Motor Time" be entered as shown in the calibration procedure. FULL CALIBRATION IS NOT REQUIRED.

Equipment needed

None

Connections

Apply power and allow the controller to warm up 15 minutes before you calibrate.
Leave all field wiring connected to the rear terminals.

Auto mode vs Manual mode

There are two ways in which to calibrate Position Proportional or 3 Position Step control:
AUTO mode or MANUAL mode.

Rules for Auto mode vs Manual mode

The Auto-mode selection must be done at least once before the manual mode will operate properly. Failure to use the Auto-mode procedure will prevent the controller from going into automatic control mode.

Displayed values

During the Auto-mode calibration procedure, the values being displayed are used only to indicate if the motor is still traveling.
To view the actual calibration value, use the manual mode after the Auto-mode is completed. These values can be changed for purposes of tweaking the calibration.

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685 793

8.3 Positi n Prop rti nal and Three P sition Step Output Calibration, Continued

Procedure

The procedure for calibrating the Position Proportional output and 3 Position Step control output is listed in table 8-3.

Make sure "LOCKOUT" in Tuning Set Up group is set to "NONE." See *Section 3 – Configuration.*

For *"Three Position Step Control Output models __without__ Motor Position Indication"*, do steps 1 and 2 only.

For *"Position Proportional Output"* and *"Three Position Step Control Output models __with__ Motor Position Indication"* follow the entire calibration procedure.

Table 8-3 Position Proportional and 3 Position Step Output Calibration Procedure

Step	Description	Press	Action
1	Enter Calibration Mode	SET UP until you see	Upper Display: CALIB Lower Display: POS PROP
2	Set Motor Traverse Time Note: This is the time it takes the motor to travel from 0 to 100%.	FUNCTION	Until you see: Upper Display: ← a value Lower Display: MTR TIME
		▲ or ▼	until the proper motor stroke time is reached (see the motor specs or measure the time) Range of setting = 5 to 1800 Seconds

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8.3 Positi n Pr p rtional and Three Position Step Output Calibration, Continued

Table 8-3 Position Proportional and 3 Position Step Output Calibration Procedure, continued

Step	Description	Press	Action
3	Select Automatic or Manual Calibration	FUNCTION	until you see: Upper Display DISABLE Lower Display POS PROP You can calibrate the controller output manually or let the controller calibrate the output automatically. If the slidewire has never been calibrated, you must use "DO AUTO" first. In the "Automatic Calibration Mode" (DO AUTO), the controller relays automatically move the motor in the proper direction. If desired, however, the motor may be manually positioned to 0% and 100% positions. Disconnect the relay wires. "DO MAN". In the "Manual Calibration Mode" (DO MAN) the motor does not move. Instead, the existing 0% and 100% values may be changed with the ▲ or ▼ keys.
		▲ or ▼	to select automatic or manual calibration. Upper Display ← DO AUTO or DO MAN Lower Display POS PROP If you select DO AUTO, go to step 4 If you select DO MAN, go to step 6 Note: When calibration is terminated, this selection reverts to DISABL.
4	DO AUTO Set 0% value	FUNCTION	The decrement relay is turned on to move the motor to 0% position. Upper Display ← counts of feedback slidewire (0 to 3000) Lower Display ZERO VAL When the motor stops, the display should stop counting, then, go on to the next step.
5	Set 100% value	FUNCTION	The increment relay is turned on to move the motor to 100% position. Upper Display ← counts of feedback slidewire (0 to 3000) Lower Display SPAN VAL When the motor stops, the display should stop counting, then, go on to step 8.

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8.3 Positi n Prop rti nal and Thr e P siti n Step Output Calibrati n, Continued

Table 8-3 Position Proportional and 3 Position Step Output Calibration Procedure, continued

Step	Description	Press	Action
6	DO MAN Set 0% value	FUNCTION	You will see: Upper Display: [ ] ← The existing zero calibration value in counts. Lower Display: ZERO VAL
		▲ or ▼	until the desired zero value is reached in the upper display. Upper Display: [ ] ← The desired zero value Lower Display: ZERO VAL
7	Set 100% value	FUNCTION	The controller will store the 0% value and you will see: Upper Display: [ ] ← The existing span calibration value in counts Lower Display: SPAN VAL
		▲ or ▼	until the desired span value is reached in the upper display. Upper Display: [ ] ← The desired span value Lower Display: SPAN VAL For manual calibration, the motor does not move from its position prior to the start of Position Proportional calibration.
8	Exit the Calibration Mode	FUNCTION	The controller will store the 100% value.
		LOWER DISPLAY or SET UP	To exit the calibration mode.

8.4 Auxiliary Output Calibration

Introduction

Calibrate the controller so that the Auxiliary outp.ıt provides the proper amount of current over the desired range.
The controller can provide an auxiliary output current range of from 0 to 21 milliamperes and can be calibrated at 4 mA for 0% of output and 20 mA for 100% of output or any other values between 0 and 21 mA.

Equipment needed

You will need a standard shop type milliammeter with whatever accuracy is required, capable of measuring 0 to 20 milliamps.

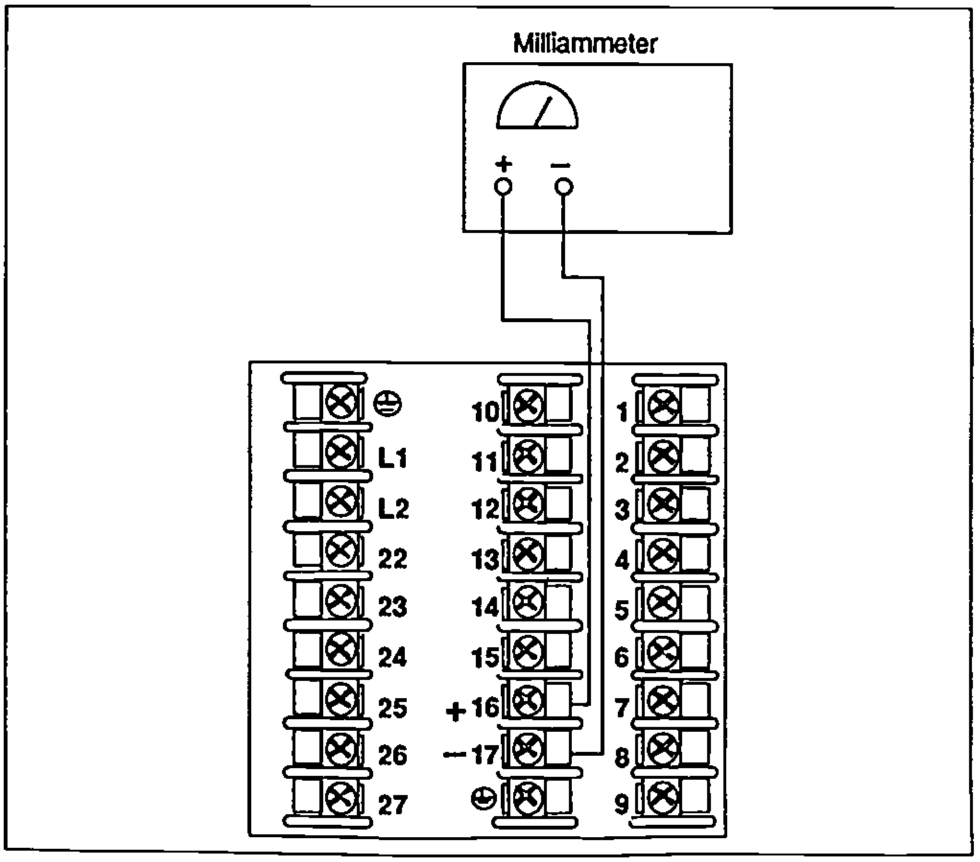
Calibrator connections

Refer to figure 8-2 and wire the controller according to the procedure given in table 8-4

Table 8-4 Set Up Wiring Procedure for Auxiliary Output

Step	Action
1	Apply power and allow the controller to warm up 15 minutes before you calibrate.
2	Tag and disconnect the field wiring, at the rear of the controller, from terminals 16(+) and 17(–). See figure 8-2.
3	Connect a Milliammeter across these terminals.

Figure 8-2 Wiring Connections for Calibrating Auxiliary Output



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8.4 Auxiliary Output Calibrati n, Continued

Procedure

The procedure for calibrating the Auxiliary Output is listed in table 8-5. Make sure "LOCKOUT" in the Tuning Set Up group is set to "NONE." See *Section 3 – Configuration.*

Table 8-5 Auxiliary Output Calibration Procedure

Step	Description	Press	Action
1	Enter Calibration Mode	SET UP *until you see*	Upper Display CALIB Lower Display AUX OUT
2	Calibrate 0%	FUNCTION	You will see: Upper Display [ ] ← a value Lower Display ZERO VAL
		▲ or ▼	until the desired 0% output is read on the milliammeter. Use the values shown below depending on the action of your controller. 0 mA For 0 to 20 mA Direct Action * 20 mA For 0 to 20 mA Reverse Action 4 mA For 4 to 20 mA Direct Action 20 mA For 4 to 20 mA Reverse Action
3	Calibrate 100%	FUNCTION	This stores the 0%value and, you will see: Upper Display [ ] ← a value Lower Display SPAN VAL
		▲ or ▼	until the desired 100% output is read on the milliammeter. Use the values shown below depending on the action of your controller. 20 mA For 0 to 20 mA Direct Action 0 mA For 0 to 20 mA Reverse Action* 20 mA For 4 to 20 mA Direct Action 4 mA For 4 to 20 mA Reverse Action
4	Exit the Calibration Mode	FUNCTION	The controller will store the span value.
		LOWER DISPLAY or SET UP	To exit the calibration mode. * When attempting to achieve 0 mA, always adjust the output to about 0.5 mA, and slowly decrease until the output just goes to zero. Further decrementing will not change the output current (since the circuit cannot produce negative current) but will affect the accuracy of the output by creating a dead zone where no current flows.

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Section 9 – Troubleshooting / Service

9.1 Overview

Introduction

Instrument performance can be adversely affected by installation and application problems as well as hardware problems. We recommend that you investigate the problems in the following order;

- Installation related problems
- Application related problems
- Hardware and software related problems

and use the information presented in this section to solve them.
If a replacement of any part is required, follow the procedures listed under "Parts Replacement Procedures".

What's in this section?

The following topics are covered in this section.

Continued on next page

9.1 Overview, Continued

Installation related problems

Read the Installation section in this manual to make sure the UDC3000 has been properly installed. The installation section provides information on protection against electrical noise, connecting external equipment to the controller, and shielding and routing external wiring.

ATTENTION System noise induced into the controller will result in diagnostic error messages recurring. If the diagnostic error messages can be cleared, it indicates a "soft" failure and is probably noise related.
If system noise is suspected, completely isolate the controller from all field wiring. Use calibration sources to simulate PV and check all controller functions; i.e. Gain, Rate, Reset, Output, Alarms, etc.

Application related problems

Review the application of the controller; then, if necessary, direct your questions to the local sales office.

Hardware and software related problems

Use the troubleshooting error message prompts and controller failure symptoms to identify typical failures which may occur in the controller. Follow the troubleshooting procedures to correct them.

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9.2 Troublesho ting Aids

Overall error messages

An error message can occur

- at power-up
- during continuous background tests while in normal operation
- when the Status Tests are requested

Table 9-1 lists all the error message prompts that you could see, the reason for the failure, and under what test group the prompt could appear.
Refer to Tables 9-3 (Power-up), 9-5 (Status), and 9-6 (Background) for the particular test group indicated.

Table 9-1 Error Message Prompts

Error Message (lower display)	Reason for Failure	Test Group	Refer to Table
CAL TEST	Calibration test failure	Power-up or Status	9-3 9-5
CONF ERR	Low limit greater than high limit for PV, SP, Reset, or Output	Background	9-6
CONFTEST	Configuration test failure	Power-up or Status	9-3 9-5
E E FAIL	Unable to write to non-volatile memory	Background	9-6
FACT CRC	Factory Calibration Cyclic Redundancy test	Status	9-5
FAILSAFE	Controller in Failsafe	Power-up, Background, or Status	9-3 9-5 9-6
INP1FAIL	Two consecutive failures of Input 1 integration	Background	9-6
INP2FAIL	Two consecutive failures of Input 2 integration	Background	9-6
INP1 RNG	Input 1 Out of Range	Background	9-6
INP2 RNG	Input 2 Out of Range	Background	9-6
PV LIMIT	PV Out of Range	Background	9-6
RAM TEST	RAM test failed	Power-up or Status	9-3 9-5
RV LIMIT	Remote Variable Out of Range	Background	9-6
SW FAIL	Position Proportional slidewire input failure	Background	9-6
CAL MTR	Position Proportional or 3 Position Step control with motor position indication, Auto Cal never performed.	Power-up	9-3

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9.2 Troublesh oting Aids, Continued

Controller failure symptoms

Other failures may occur that deal with the Power, Output, or Alarms. Refer to the controller failure symptom in Table 9-7 to determine what is wrong and the troubleshooting procedures to use to correct the problem.

Check installation

If a set of symptoms still persists, refer to *Section 2 - Installation* and ensure proper installation and proper use of the controller in the system.

Customer support

If you cannot solve the problem using the troubleshooting procedures listed in this section; or get the **model number** and **serial number** from the label on the chassis molding, and **software** version (see Table 9-2) then:

call Customer Support Phone Number 1-800-423-9883.

If it is determined that a hardware problem exists and the controller is still within the two year warranty, a replacement controller will be shipped with instructions for returning the defective unit.

Determining the software version

Table 9-2 lists the procedure for identifying the software version number.

Table 9-2 Procedure for Identifying the Software Version

Step	Operation	Press	Action
1	Select STATUS Set Up Group	SET UP	Until you see: Upper Display READ Lower Display STATUS
2	Read the software version	FUNCTION	Until you see: Upper Display [ ] ← Software version Number Lower Display VERSION Please give this number to the Customer Support person. It will indicate which version of UDC3000 you have and help them determine a solution to your problem.

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9.3 Power-up Tests

What happens at power-up

When the controller is powered-up, three tests are run by the UDC3000 software to ensure memory integrity.
As the tests are run, the displays will appear as shown in Table 9-3.

Table 9-3 Power-up Tests

Lower Display	Upper Display
RAM TEST	PASSED or FAILED
CONFTEST	PASSED or FAILED
CAL TEST	PASSED or FAILED

Test failures

If any of these three tests fail, "FAILED" will appear momentarily in the upper display, then a display test is run, after which the controller will go into manual mode and you will see:

Upper Display
[ ] ← PV value

Lower Display
[FAILSAFE] (blinking)

Refer to "*Status Tests*" to determine which tests have failed and how to correct them.

Position proportional or 3 position step test failures

For controller configured for Position Proportional or 3 Position step control with motor position indication and Auto-cal has never been done, a prompt "CAL MTR" will appear suggesting that the controller be calibrated.

9.4 Status Tests

Introduction

When required, the results of these tests can be checked to determine the reason the controller has gone to "Failsafe".

How to check the status tests

The procedure in Table 9-4 tells you how to display the results of the status tests. Table 9-5 lists the tests, the reason for the failure, and how to correct the problem.

Table 9-4 Procedure for Displaying the Status Tests Results

Step	Operation	Press	Action
1	Select STATUS Set Up Group	SET UP	Until you see: Upper Display READ Lower Display STATUS
2	Read the status tests results	FUNCTION	Until you see: Upper Display NO or YES — YES indicates a failure Lower Display FAILSAFE Successive presses of the [FUNCTION] key will display the results of the status tests in the following order: RAM TEST CONF TEST CAL TEST FACT CRC Identify the problem and correct the failure as shown in Table 9-5.

Continued on next page

685 805

9.4 Status Tests, Continued

Status Tests

Table 9-5 lists the Status tests, the reason for their failure, and how to correct the failure.

Table 9-5 Status Tests

Test (Lower Display)	Definition	Upper Display	Reason for Failure	How to Correct the Failure
FAILSAFE	Failsafe Fault	NO	No Failure	
		YES	Burnout configured for none and input fails. –RAM TEST failed –CONFTEST failed –CALTEST failed	1. Step through the rest of the STATUS check to identify the particular failure. Also see Table 9-6, Background tests
RAM TEST	RAM test run at power-up	PASS	No Failure	RAM test passed.
		FAIL	RAM Failure	1. Power cycle to see if the error clears.
CONF TEST	Configuration Checksum	PASS	No Failure	Configuration checksum passed.
		FAIL	Configuration data is in error.	1. Step through STATUS tests – the controller will recalculate the checksum. 2. Check all configuration prompts for accuracy. See *Section 3 - Configuration*
CAL TEST	Working Calibration	PASS	No Failure	Working calibration checksum passed.
		FAIL	The working calibration constants in the controller are in error.	1. If the controller has not been field calibrated, see *Section 3 - Configuration* and change the input to a different type. Enter it, loop through the status tests, then return the input type to the original one. 2. If the controller has been field calibrated, recalibrate the controller.
FACT CRC	Factory calibration test	PASS	No Failure	Factory calibration cyclic redundancy test passed
		FAIL	Factory set input constants have been changed due to the change in input type.	1. Cycle through Status to clear the error. 2. Check the calibration. Make sure 0 and 100% are correct values. 3. Recalibrate if step 1 is unsatisfactory. Refer to *Section 7 - Input Calibration.*

9.5 Background Tests

Introduction

The UDC3000 performs on-going background tests to verify data and memory integrity. If there is a malfunction, an error message will be displayed (blinking) in the lower display.

Background Tests

In the case of more than one simultaneous malfunction, only the one with the highest priority will appear in the lower display. Table 9-6 lists these background tests, the reason for their failure, and how to correct the problem.

Table 9-6 Background Tests

Lower Display	Reason for Failure	How to Correct the Problem
EE FAIL	Unable to write to non-volatile memory. Anytime you change a parameter and it is not accepted, you will see EE FAIL.	1. Check the accuracy of the parameter and re-enter. 2. Try to change something in configuration. 3. Run through STATUS tests to re-write to EEPROM.
FAILSAFE	This error message shows whenever the controller goes into a failsafe mode of operation. This will happen if: • RAM test failed • Configuration test failed • Calibration test failed • Burnout configured for none and the input failed.	1. Run through STATUS check to determine the reason for the failure. 2. Press the SET UP key until STATUS appears in the lower display. 3. Press the FUNCTION key to see what tests pass or fail, then run through the STATUS codes a second time to see if the error cleared. Correct according to the recommendations given in table 9-5.
INP1FAIL	Two consecutive failures of input 1 integration. i.e., cannot make analog to digital conversion. This will happen if: • Upscale or Downscale burnout is selected • Input not configured correctly	1. Make sure the actuation is configured correctly. See *Section 3 - Configuration.* 2. Make sure the input is correct. 3. Check for gross over-ranging. 4. Replace the cold junction assembly.
INP2FAIL	Two consecutive failures of input 2 integration. i.e., cannot make analog to digital conversion.	1. Make sure the actuation is configured correctly. See Section 3 - Configuration. 2. Make sure the input is correct. 3. Check for gross over-ranging.
SW FAIL	Position Proportional input slidewire failure	1. Check motor slidewire connections. 2. Recalibrate the slidewire motor position. see the calibration section.
CONF ERR	• PV low limit is > PV high limit • SP low limit is > SP high limit • Output low limit > Output high limit	1. Check the configuration for each item and reconfigure if necessary.

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685 807

9.5 Background Tests, Continued

Table 9-6 Background Tests, continued

Lower Display	Reason for Failure	How to Correct the Problem
INP1 RNG	Input 1 out of range. The process input is outside the range limits. If you have a linear input and the range goes outside the range limits, the controller will switch to the configured Failsafe output value.	1. Make sure the range and actuation are configured properly. 2. Check the input source. 3. Restore the factory calibration: a. Disconnect the wiring from and place a jumper across terminals 26 and 27. The controller should read room temperature if it is configured for a thermocouple input. b. If it does not read room temperature, see *Section 3-Configuration* and change the IN1TYP prompt in the INPUT 1 group to another type of thermocouple. c. After the change, press [FUNCTION] key, then the [LOWER DISPLAY] key. The controller should read the correct room temperature. If it does not, the unit has an input failure. d. Repeat step b. This time switch the IN1TYP back to the originally selected thermocouple. e. Repeat step c. The controller is restored with factory calibration. f. Remove the jumper and reconnect the thermocouple. 4. Field calibrate. See *Section 7 - Input Calibration.*
INP2 RNG	Input 2 out of range. The remote input is outside the range limits.	1. Make sure the range and actuation are configured properly. 2. Check the input source. 3. Field calibrate. See *Section 7 - Input Calibration.*
PV LIMIT	PV out of range. PV = INP1 + INP1 BIAS	1. Make sure the input signal is correct. 2. Make sure the Bias setting is correct 3. Recheck the calibration. Use Bias of 0.0
RV LIMIT	The result of the formula shown below is beyond the range of the remote variable. RV = INP2 X RATIO + BIAS	1. Make sure the input signal is correct. 2. Make sure the Ratio and Bias settings are correct. 3. Recheck the calibration. Use a Ratio of 1.0 and a Bias of 0.0.

685 808

9.6 Controller Failure Symptoms

Introduction

In addition to the error message prompts, there are failure symptoms that can be identified by noting how the controller displays and indicators are reacting.

Symptoms

Compare your symptoms with those shown in Table 9-7 and refer to the troubleshooting procedure indicated to correct the problem.

Table 9-7 Controller Failure Symptoms

<table>
<tr><th>Upper Display</th><th>Lower Display</th><th>Indicators</th><th>Controller Output</th><th>Probable Cause</th><th>Trouble-shooting Procedure</th></tr>
<tr><td>Blank</td><td>Blank</td><td>Off</td><td>None</td><td>Power Failure</td><td>1</td></tr>
<tr><td>OK</td><td rowspan="4">Displayed Output disagrees with Controller Output</td><td>OK</td><td rowspan="4">Controller Output disagrees with Displayed Output</td><td>Current Proportional Output</td><td>2</td></tr>
<tr><td>OK</td><td>OK</td><td>Position Proportional Output</td><td>3</td></tr>
<tr><td>OK</td><td>OK</td><td>Time Proportional Output</td><td>4</td></tr>
<tr><td>OK</td><td>OK</td><td>Current/Time Proportional Output</td><td>5</td></tr>
<tr><td>OK</td><td>OK</td><td>OK</td><td>External Alarm function does not operate properly</td><td>Malfunction in alarm output</td><td>6</td></tr>
<tr><td colspan="4">Display does not function when a key is pressed</td><td>Keyboard Malfunction</td><td>7</td></tr>
<tr><td colspan="4">Controller fails to go into "Slave" operation during communications</td><td>Communications Failure</td><td>8</td></tr>
</table>

Other symptoms

If a set of symptoms or prompts other than the one you started with appears while troubleshooting, re-evaluate the symptoms. This may lead to a different troubleshooting procedure.
If the symptom still persists, refer to the installation section in this manual to ensure proper installation and proper use of the controller in your system.

685 809

9.7 Troubleshooting Pr cedures

Introduction

The troubleshooting procedures are listed in numerical order as they appear in Table 9-7. Each procedure lists what to do if you have that particular failure and how to do it or where to find the data needed to accomplish the task.

Equipment needed

You will need the following equipment in order to troubleshoot the symptoms listed in the tables that follow:

- DC Milliammeter – mAdc
- Calibration sources – T/c, mV, Volt, etc.
- Voltmeter

Procedure #1

Table 9-8 explains how to troubleshoot power failure symptoms.

Table 9-8 Troubleshooting Power Failure Symptoms

Step	What to do	How to do it
1	Check the AC line voltage.	Use a Voltmeter to measure the AC voltage across terminals L1 and L2 on the rear terminal panel of the controller. Check the earth ground connection.
2	Make sure the chassis plugs into the rear of the case properly.	Withdraw the chassis and visually inspect the controller board and the inside of the case.
3	Check the system for Brown-outs, heavy load switching, etc.; and conformance to installation instructions.	Refer to *Section 2 - Installation.*

Continued on next page

9.7 Troubleshooting Procedures, Continued

Procedure #2

Table 9-9 explains how to troubleshoot Current Proportional Output failure symptoms.

Table 9-9 Troubleshooting Current Proportional Output Failure

Step	What to do	How to do it
1	Make sure the controller is configured for Current output.	Make Set Up group prompt "ALGORTHM". Function prompt "OUT ALG" = selection "CURRNT" Refer to *Section 3 - Configuration.*
2	Check the field wiring.	Output impedance must be less than or equal to 1000 Ohms.
3	Make sure all the configurable tuning constants, limits, and configuration data stored in the controller are correct. Reconfigure, if necessary.	Refer to *Section 3 - Configuration* to check all this data and how to reconfigure.
4	Check the output.	Put the controller into Manual mode and change the output from 0 to 100% (4-20 mA). Use a DC milliammeter at the rear terminals to verify the output.
5	Recalibrate the Current Proportional Output.	Refer to *Section 8 - Output Calibration* for details.

Continued on next page

685 811

9.7 Troubleshooting Pr cedures, Continued

Procedure #3

Table 9-10 explains how to troubleshoot Position Proportional Output failure symptoms.

Table 9-10 Troubleshooting Position Proportional Output Failure

Step	What to do	How to do it
1	Make sure the controller is configured for Position Proportional output.	Make Set Up group prompt "ALGORTHM". Function prompt "OUT ALG" = selection "POSITN" Refer to *Section 3 - Configuration*.
2	Check the field wiring.	Refer to *Section 2 - Installation* for Position Proportional Wiring information.
3	Check the output.	Put the controller into Manual mode and change the output from 0 to 100%.
4	Check whether the motor drives in both directions. If it does go to step 6.	See the Position Proportional calibration procedure in the Calibration Section for motor slidewire calibration.
5	Check whether the motor drives in either direction. If the motor drives in one direction, check the slidewire. If the motor does not drive in either direction, check the motor.	Refer to the Motor instructions.
6	Check the output voltage to the slidewire.	Should equal from 1.3 to 1.0 volts. See wiring in the installation section for terminal designations. The feedback slidewire output voltage must vary with the valve position.
7	Make sure the output relays are actuating properly.	Put the controller into Manual mode. Vary the output above and below the present value.Observe "OUT" indicator on the operator interface. If they are not working properly, check the field wiring, then go to step 5. If they are, go to step 8.
8	Recalibrate the controller.	Refer to Section 8 - *Output Calibration*.

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9.7 Troubleshooting Procedures, Continued

Procedure #4

Table 9-11 explains how to troubleshoot Time Proportional Output failure.

Table 9-11 Troubleshooting Time Proportional Output Failure

Step	What to do	How to do it
1	Make sure the controller is configured for Time Proportional output.	Make Set Up group prompt "ALGORTHM". Function prompt "OUT ALG" = selection "TIME" or "TIME D" Refer to *Section 3 - Configuration*.
2	Check the field wiring.	Make sure the NO or NC contact wiring is correct at the rear terminals. Refer to *Section 2 - Installation* for details.
3	Make sure all the configurable tuning constants, limits, and configuration data stored in the controller are correct. Reconfigure, if necessary.	Refer to *Section 3- Configuration* to check all this data and how to reconfigure.
4	Check the output.	Put the controller into Manual mode. Vary the output above and below the present value. Observe "OUT" indicator on the operator interface.

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9.7 Troubleshooting Procedures, Continued

Procedure #5

Table 9-12 explains how to troubleshoot Current/Time or Time/Current Proportional Output failure.

Table 9-12 Troubleshooting Time/Current or Current/Time Proportional Output Failure

Step	What to do	How to do it
1	Make sure the controller is configured for Time/Current or Current/Time Proportional output.	Make Set Up group prompt "ALGORTHM". Function prompt "OUT ALG" = selection "TI CUR" or "CUR TI" Refer to *Section 3 - Configuration.*
2	Check the field wiring.	Make sure the NO or NC contact wiring is correct at the rear terminals. Refer to *Section 2 - Installation* for details.
3	Make sure all the configurable tuning constants, limits, and configuration data stored in the controller are correct. Reconfigure, if necessary.	Refer to *Section 3 - Configuration* to check all this data and how to reconfigure.
4	Check the relay output.	Put the controller into Manual mode. Vary the output above and below the present value. Observe "OUT" indicator on the operator interface.
5	Check the Current Proportional Output.	Put the controller into Manual mode and change the output from 0 to 100% (4-20 mA). Use a DC milliammeter at the rear terminals to verify the output.
6	Recalibrate the controller.	Refer to *Section 8 - Output Calibration* for details

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9.7 Troubleshooting Procedures, Continued

Procedure #6

Table 9-13 explains how to troubleshoot Alarm Relay Output failure.

Table 9-13 Troubleshooting Alarm Relay Output Failure

Step	What to do	How to do it
1	Check the alarm configuration data. If it is correct, check the field wiring.	Reconfigure if necessary. Refer to *Section 3 - Configuration* for details.
2	Check that the applicable alarm relay actuates properly depending on what you have set at prompt "ALARM TYPE". If it does, check the field wiring.	If the alarm type is set for PV, place the controller in manual mode. Vary the input to raise and lower the PV around the setpoint. Listen for a click from the relay as the PV moves in either direction and note that the proper ALM1 or ALM2 is lit. If the alarm is set for output, put the controller into manual mode. Raise or lower the output above or below the value you have set as the alarm setpoint.
3	Check the field wiring.	Make sure the NO or NC contact wiring is correct on the alarm output terminals. Refer to *Section 2 - Installation* for details.

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685 815

9.7 Troubleshooting Procedures, Continued

Procedure #7

Table 9-14 explains how to troubleshoot a Keyboard failure.

Table 9-14 Troubleshooting a Keyboard Failure

Step	What to do	How to do it
1	Make sure the keyboard is connected properly to the MCU/output and power/input boards.	Withdraw the chassis from the case and visually inspect the connection.
2	Controller Keyboard or specific keys may be "LOCKED OUT" via the security code.	Use your 4 digit security code number to change the lockout level. Refer to *Section 3 – Configuration.* ATTENTION Using "1000" as a security code number will override the 4-digit code previously entered.
3	Run the keyboard test.	Press the [SET UP] key and hold in, then press the [FUNCTION] key at the same time. The controller will run a display test. Then you will see: Upper Display KEYS Lower Display TRY ALL Press each key. If it works, the key name will appear in the lower display.
4	Replace the display/keyboard if any keys are shorted out.	Refer to *"Parts Replacement Procedures"* in this section.

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9.7 Troubleshooting Procedures, Continued

Procedure #8

Table 9-15 explains how to troubleshoot a Communications failure.

Table 9-15 Troubleshooting a Communications Failure

Step	What to do	How to do it
1	Check the field wiring and termination resistor.	Refer to the RS422/485 Manual or the Gateway Manual depending on the protocol used.
2	Make sure the Communications Printed Wiring Board is installed properly in the controller.	Withdraw the chassis from the case and inspect the board. See the exploded view (Figure 10-1) for location of the board. Return the chassis to the case.
3	Determine if the Communications board is faulty by running a LOCAL LOOPBACK TEST. If the test fails, replace the board.	Run the Local Loopback Test. Press [SET UP] until you see: Upper Display: SET UP Lower Display: COM Press [FUNCTION] until you see: Upper Display: DISABL Lower Display: LOOPBACK Press ▲ or ▼, you will see: Upper Display: Enable Lower Display: LOOPBACK The test will run until the operator disables it here.

685 817.

9.8 Parts Replacement Procedures

Introduction

These procedures tell you how to access and replace the following printed wiring boards in your controller.

- Display/Keyboard
- MCU/Output
- Power/Input
- 2nd Input
- Digital Input
- Auxiliary Output
- DMCS Communications
- RS422/485 Communications

Equipment needed

To accomplish the procedures that follow, you will need the following equipment:

- Phillips Head Screwdriver
- Flat Bladed Screwdriver
- Small Pliers

Continued on next page

9.8 Parts Replacement Procedures, *Continued*

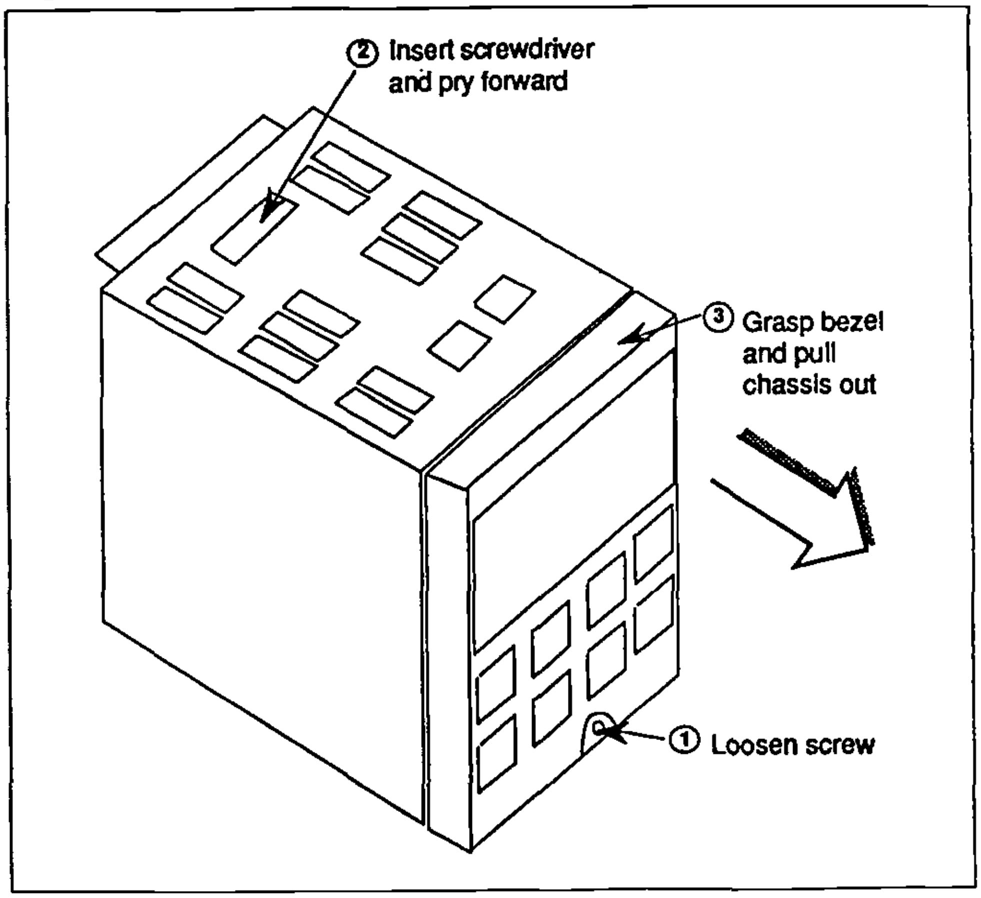
How to remove the chassis

Refer to Figure 9-1 for steps and follow the procedure listed in Table 9-16.

Table 9-16 How to remove the chassis

Step	Action
1	Loosen the screw on the front face.
2	Insert a flat-bladed screwdriver into the hole on the top of the case as shown in Figure 9-1 and pry chassis forward *slightly* until the chassis connectors separate from the back of the case.
3	Grasp the bezel and pull the chassis out of the case.

Figure 9-1 Chassis Removal



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9.8 Parts Replacement Procedures, Continued

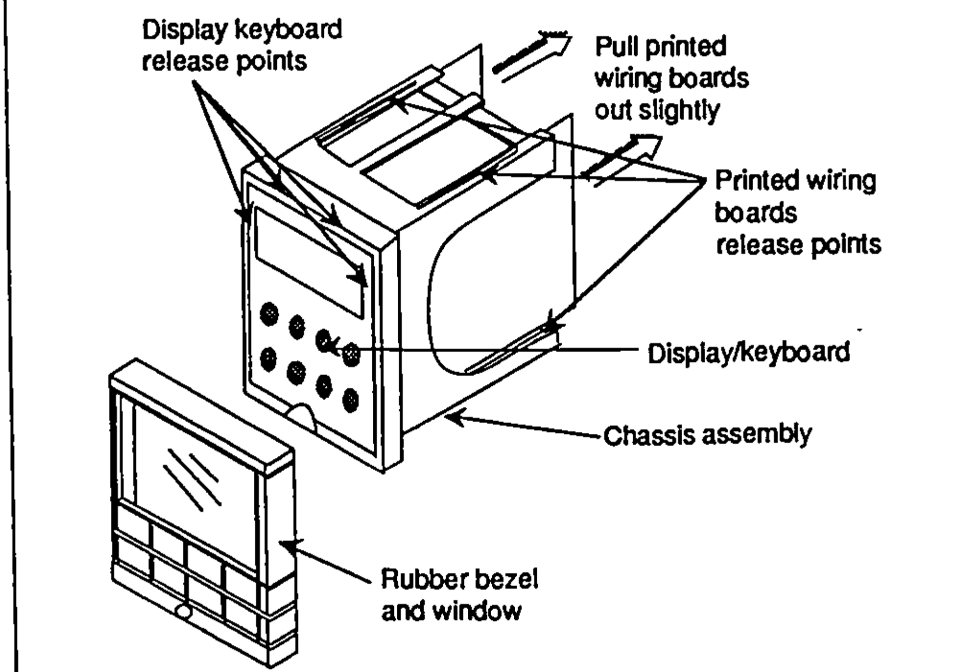
How to replace the display/keyboard assembly

Refer to Figure 9-2 and follow the procedure listed in Table 9-17.

Table 9-17 Display/Keyboard Assembly Replacement Procedure

Step	Action
1	Remove the chassis from the case as shown in Figure 9-1.
2	Peel the rubber bezel and display window off the chassis assembly.
3	Separate the chassis frame at the four release points shown in Figure 9-2 and wiggle each printed wiring board out of its socket on the display/keyboard assembly. Pull out slightly.
4	Insert a small flat-bladed screwdriver into each of the display/keyboard release points (Figure 9-2) and pry out the board.
5	Install the new board, bottom end in first, and push in the top until it clicks into place.
6	Reinstall the printed wiring boards into the rear of the display board making sure that the boards click into their release points.
7	Replace the bezel and window assembly.
8	Reinstall chassis into case. Press in hard, then tighten the screw.

Figure 9-2 Display/Keyboard Replacement



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9.8 Parts Replacement Procedures, Continued

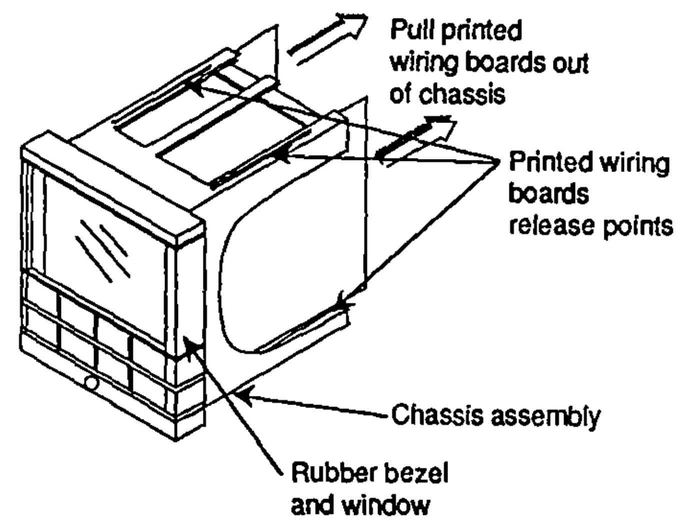
How to remove the printed wiring boards from the chassis

To remove the printed wiring boards from the chassis, refer to Figure 9-3 and follow the procedure in Table 9-18.

Table 9-18 Printed Wiring Board Removal from Chassis

Step	Action
1	Remove the chassis from the case as shown in Figure 9-1.
2	Separate the chassis frame at the release points shown in Figure 9-3 and wiggle each printed wiring board out of its socket on the display/keyboard assembly. Pull both boards out of the chassis assembly.

Figure 9-3 Removing the Printed Wiring Boards



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685 821

9.8 Parts Replacement Pr c dures, Continued

Printed wiring board identification

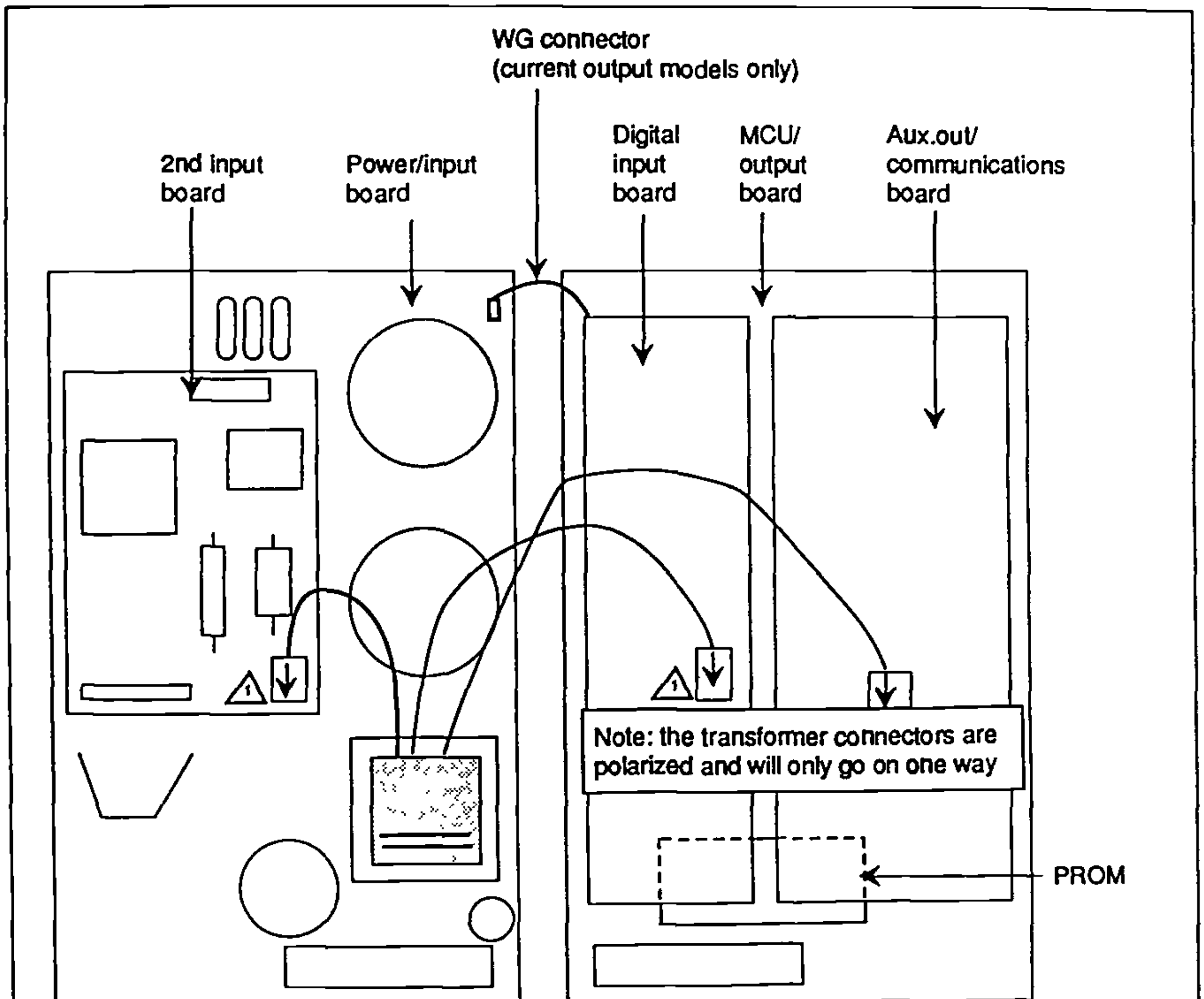
Figure 9-4 identifies each of the printed wiring boards that can be replaced. Refer to this drawing when following the replacement procedures for each of the boards, since you have to remove all of them from the chassis to replace the one you want.

In order to lay boards flat, remove the transformer lead from the Aux.Out/Communications board and the Digital Input board.

Refer to the specific procedure table to remove the desired board.

- 2nd Input Board — Table 9-19
- Power Input Board — Table 9-20
- Digital Input Board — Table 9-21
- Aux.Out/Communications Board — Table 9-22
- MCU/Output Board — Table 9-23

Figure 9-4 Printed Wiring Board Identification



⚠1 2-Pin Transformer connections are interchangeable. Either may be used on Digital Input Board or the second Input Board

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9.8 Parts Replacement Procedures, Continued

2nd Input board

Follow the procedure listed in Table 9-19 to replace the Second Input board—P/N 30756715-501.

Table 9-19 Second Input Board Replacement Procedure

Step	Action
1	Remove the chassis from the case. See Figure 9-1.
2	Remove the printed wiring boards from the chassis. See Figure 9-3.
3	Lay the boards flat and identify the 2nd Input board. See Figure 9-4.
4	Remove the transformer plug from connector J14.
5	The 2nd Input board is attached to the Power Input board by three mounting posts. Locate these posts under the power input board.
6	Use a small pliers and squeeze the ends of each post together and push it up through the board. Remove 2nd Input board.
7	Orient the new 2nd Input board onto the Power Input board and push the mounting posts down through the Power Input board until they click into place.
8	Replace the transformer plug onto connector J14.
9	Slide the printed wiring boards back into the chassis. Make sure the connections to the display/keyboard assembly are made and that the release points on the chassis snap into place on the printed wiring boards.
10	Reinstall the chassis into the case. Push in hard, then tighten screw.

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685 823

9.8 Parts Replacement Procedur s, Continued

Power Input board

Follow the procedure listed in Table 9-20 to replace the Power Input board—P/N 30756669-501.

Table 9-20 Power Input Board Replacement Procedure

Step	Action
1	Remove the chassis from the case. See Figure 9-1.
2	Remove the printed wiring boards from the chassis. See Figure 9-3.
3	Lay the boards flat and identify the Power Input board. See Figure 9-4.
4	Remove the 2nd Input board, if present. See procedure in Table 9-19.
5	Remove the transformer connections to the Digital Input board and Aux.Out/Communications board, if present.
6	Remove the connector from plug WG if present (current output models only). Slide a small screwdriver under the connector and lift the release.
7	Replace the Power Input board.
8	Reinstall WG connector and transformer connections to Digital Input board and Aux.Out/Communications board, if present.
9	Reinstall the 2nd Input board. See procedure in Table 9-19.
10	Slide the printed wiring boards back into the chassis. Make sure the connections to the display/keyboard assembly are made and that the release points on the chassis snap into place on the printed wiring boards.
11	Reinstall the chassis into the case. Push in hard, then tighten screw.

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9.8 Parts Replacement Procedures, Continued

Digital Input board

Follow the procedure listed in Table 9-21 to replace the Digital Input board—P/N 30756696-501.

Table 9-21 Digital Input Board Replacement Procedure

Step	Action
1	Remove the chassis from the case. See Figure 9-1.
2	Remove the printed wiring boards from the chassis. See Figure 9-3.
3	Lay the boards flat and identify the Digital Input board. See Figure 9-4.
4	Remove the transformer plug from connector J9.
5	The Digital Input board is attached to the MCU/output board by three mounting posts. Locate these posts under the MCU/output board.
6	Use small pliers and squeeze the ends of each post together and push it up through the board. Remove the Digital Input board.
7	Orient the new Digital Input board onto the MCU/Output board and push the mounting posts down through the MCU/Output board until they click into place.
8	Replace the transformer plug onto connector J9.
9	Slide the printed wiring boards back into the chassis. Make sure the connections to the display/keyboard assembly are made and that the release points on the chassis snap into place on the printed wiring boards.
10	Reinstall the chassis into the case. Push in hard, then tighten the screw.

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9.8 Parts Replacement Proc dures, Continued

Aux.Out/ communications board

Follow the procedure listed in Table 9-22 to replace the following boards:

- Auxiliary Output Board—P/N 30756687-501
- DMCS Communications Board—P/N 30756690-501
- RS422/485 Communications Board—P/N 30756693-501

Table 9-22 Aux.Out/Communications Board Replacement Procedure

Step	Action
1	Remove the chassis from the case. See Figure 9-1.
2	Remove the printed wiring boards from the chassis. See Figure 9-3.
3	Lay the boards flat and identify the Auxiliary Output or the Communications board. See Figure 9-4.
4	Remove the transformer plug from connector J8.
5	The Aux.Out/Communications board is attached to the MCU/Output board by three mounting posts. Locate these posts under the MCU/Output board.
6	Use small pliers and squeeze the ends of each post together and push it up through the board. Remove the Aux.Out/Communications board.
7	If you are replacing a Communications Board, a new PROM is supplied with the board. Locate the PROM (shown in Figure 9-4) and gently pry out the old PROM. Orient the new PROM supplied and gently press into place.
8	Orient the new *Aux.Out/Communications* board onto the MCU/Output board and push the mounting posts down through the MCU/Output board until they click into place. .
9	Replace the transformer plug onto connector J8.
10	Slide the printed wiring boards back into the chassis. Make sure the connections to the keyboard assembly are made and that the release points on the chassis snap into place on the printed wiring boards.
11	Reinstall the chassis into the case. Push in hard, then tighten the screw.

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9.8 Parts Replacement Procedures, Continued

MCU/output board

Follow the procedure listed in Table 9-23 to replace the following MCU/output boards:

- Current Output—P/N 30756718-502
- Relay Output—P/N 30756718-503

Table 9-23 MCU/Output Board Replacement Procedure

Step	Action
1	Remove the chassis from the case. See Figure 9-1.
2	Remove the printed wiring boards from the chassis. See Figure 9-3.
3	Lay the boards flat and identify the MCU/Output board. See Figure 9-4.
4	Each option board is held onto the MCU/Output board with three posts.. Locate these posts under the MCU/Output board.
5	Use small pliers and squeeze the ends of each post together and push it up through the board. Remove the option boards present.
6	Remove the transformer connections to the Digital Input board and the Aux.Out/Communications board, if present.
7	Remove the Digital Input Board, if present. See Table 9-21.
8	Remove the Aux.Out/Communications board, if present. See Table 9-22.
9	Remove the connector from plug WG. Slide a small screwdriver under the connector and lift the release.
10	Replace the MCU/Output board.
11	Reinstall the Digital Input board, if present, onto the new MCU/Output board.
12	Reinstall the Aux.Out/Communications board, if present, onto the new MCU/Output board.
13	Reinstall the WG connector and the transformer connectors to the Digital Input board and Aux.Out/Communications board, if present.
14	Slide the printed wiring boards back into the chassis. Make sure the connections to the display/keyboard assembly are made and that the release points on the chassis snap into place on the printed wiring boards.
15	Reinstall the chassis into the case. Push in hard, then tighten the screw.

685 827

9.9 Maintenance

Cleaning

If you find it necessary to clean the elastomer bezel, use an alcohol solution or mild soapy water.

685' 828

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685 829

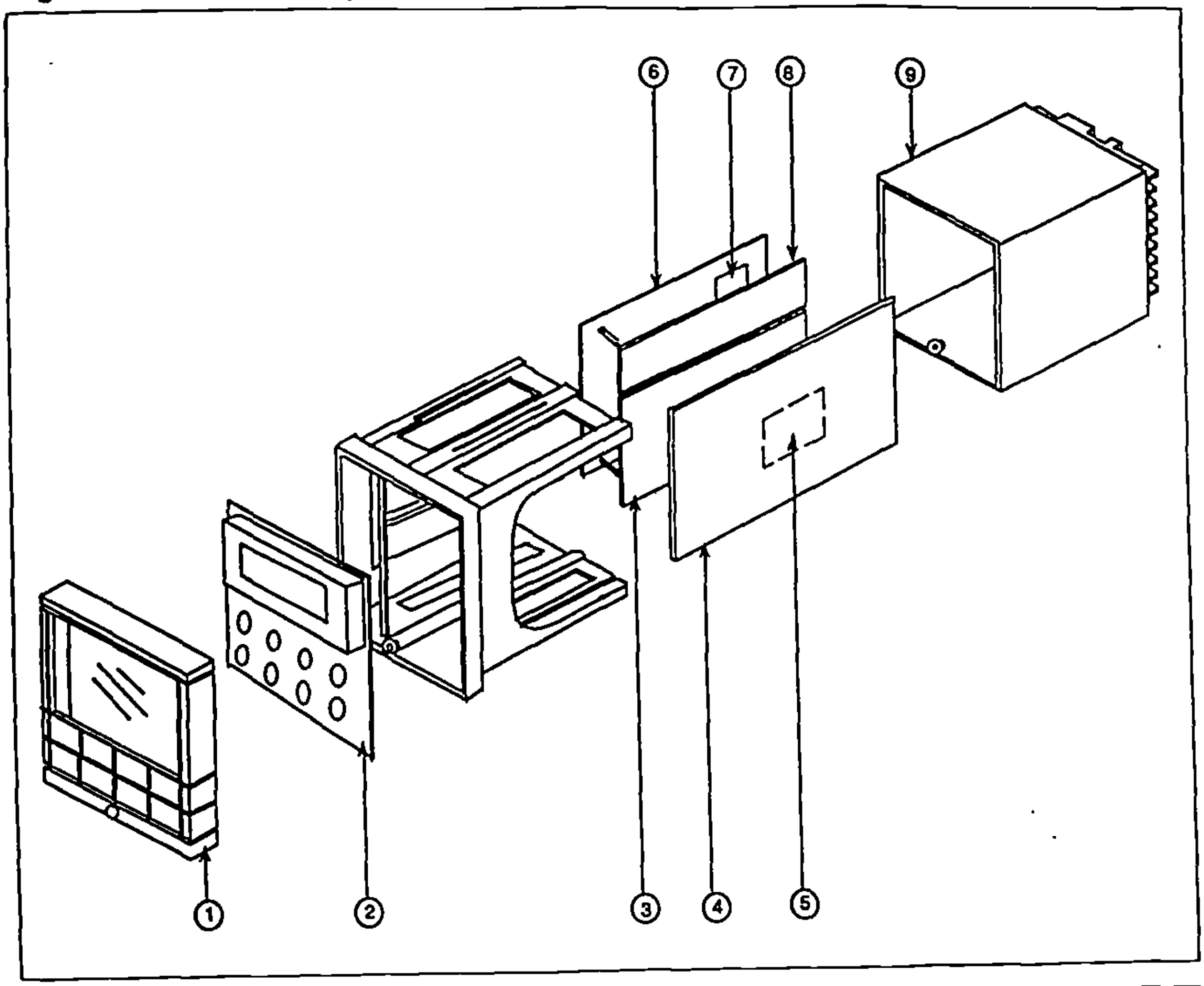
Section 10 – Parts List

10.1 Exploded View

Introduction

Figure 10-1 is an exploded view of the UDC3000 Controller. Each part is labeled with a key number. The part numbers are listed by key number in Table 10-1. There is a list of parts not shown in Table 10-2.

Figure 10-1 UDC3000 Exploded View



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10.1 Exploded View, Continued

Parts Identification

Table 10-1 lists the part numbers for the key numbers shown in the exploded view.

Table 10-1 Parts Identification

Key Number	Part Number	Description	Quantity
1	30756667-501	Bezel Assembly	1
2	30756672-501	Display/Keyboard Printed Wiring Assembly	1
3	30756687-501 30756690-501 30756693-501	Auxiliary Output Printed Wiring Board DMCS Communications Printed Wiring Board (includes new PROM) RS422/485 Communications Printed Wiring Board (includes new PROM)	1
4	30756669-501	Power/Input Printed Wiring Board	1
5	30756715-501	2nd Input Printed Wiring Board	1
6	30756718-502 30756718-503	Current Output MCU/Output Printed Wiring Board Relay Output MCU/Output printed Wiring Board	1
7	30755306-501 30756725-501 30756679-501	Relay, Electromechanical Relay, Solid State 1 Amp Open Collector Output Printed Wiring Jumper	1 per kit
8	30756696-501	Digital Input Printed Wiring Board	1
9	30756721-501	Case Assembly	1

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685 831

10.1 Exploded View, Continued

Parts not shown

Table 10-2 lists the part numbers of the parts not show in the exploded view.

Table 10-2 Parts Not Shown

Part Number	Description	Quantity
30731996-506	4-20 mA Resistor Assembly, 250 Ohms	1
30754465-501	0-10 Volt Input Resistor Assembly, 100K Pair	1
30752441-501 30752441-502	Varistor, 120V Varistor, 240V	1
30755050-001	Mounting Kit	1
30756746-001	Snubber Assembly	1
30756764-002	Rear Cover Kit	1
30755223-002 30755223-003	DIN Adapter Kit, Blue DIN Adapter Kit, Gray	1
30756774-501	Adaptive Tune Prom Upgrade	1
30756775-501	Adaptive Tune/Setpoint Programming Prom Upgrade	1
30754499-006	Cold Junction Resistor Kit	1
30756018-003	External Relay, Solid State 10 Amp	1
30756682-501	Adapter (New chassis to old case)	1
30756683-001	Gasket (Panel to case)	

Section 11 – Appendix A – Manual Tuning

11.1 Overview

Introduction

When you tune a controller, there are some things to consider:

- Process Characteristics - Gain, Time Constants, etc.
- Desired response - Minimal overshoot

Basically, controller tuning consists of determining the appropriate values for the Gain (PB), Rate (Derivative), and Reset (Integral) time tuning parameters (control constants) that will give the control you want. Depending on the characteristics of the deviation of the process variable from the setpoint, the tuning parameters interact to alter the controller's output and produce changes in the value of the process variable.

Since each parameter responds to a specific characteristic of the deviation, you may not need a combination of all three. It depends on the process characteristics and the desired control response.

Tuning technique

You can estimate a starting point and the tuning parameters required to give the desired controller response and with some experience become proficient with this method.

An alternate approach is to rely on a tuning technique. In practice, tuning techniques usually do not give exactly the type of response desired; thus, some final adjustments to the tuning parameters must be made.

However, you should at least obtain a reasonable starting point from which the desired response characteristics can be obtained.

Controller tuning procedures

There are three procedures for tuning the controller:

- Time, Position, or Current Proportional simplex control,
- Duplex Time or Current Proportional control,
- Two sets of tuning constants for single output operation.

The suggested procedures describe how to establish and store values of Gain(PB), Rate, and Reset time constants for your process. You must know the type of control and algorithm your controller has.

Tuning aids

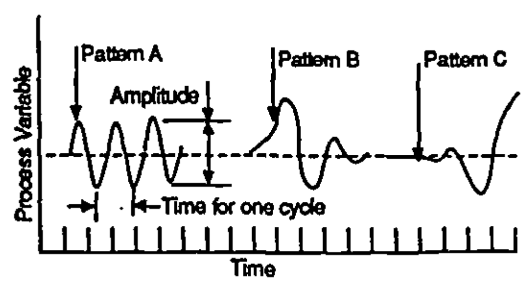
A graphic recorder (such as Honeywell model DPR, DR4500, or VP131) connected to the process variable will make it easier to determine when the oscillations are constant and also the time for one oscillation. If a recorder is not available, you can use a stop watch to time the oscillation of the process variable displayed on the controller.

11.2 Time, Position, r Curr nt Proporti nal Simplex Control

Procedure

The procedure listed in table 11-1 gives you the steps for manually tuning a controller with Time, Position, or Current proportional simplex control.

Table 11-1 Manual Tuning Procedure for Simplex Control

Step	Action
1	In Manual Mode, adjust the output to bring the PV (Process Variable) near the desired value.
2	Set the Rate time to 0 minutes and set the Reset time to the maximum value (50.00 minutes) or set repeats/min to the minimum value to minimize reset action If applicable, set the CYCLE TIME to 4 seconds and DEADBAND to 0.5.
3	*Increase* GAIN (*decrease* PB) *significantly. Try a factor of* 10.
4	Adjust the local setpoint to equal PV and switch to Automatic control mode.
5	Increase the setpoint by 5 or 10% and observe the process variable response.
6	If the PV oscillates, continue to step 7. If it does not oscillate, return to the original setpoint and increase GAIN (decrease PB) again by a factor of 2, and repeat step 5.
7	Compare the oscillations with the figure below:  • If the oscillation matches pattern A, go to step 8. • If the oscillation matches pattern B, increase GAIN (decrease PB) by a factor of 2 and repeat steps 4 to 6. • If the oscillation matches pattern C, decrease GAIN (increase PB) by a factor of 0.8 and repeat steps 4 to 6 The amplitude of the cycle is immaterial, but all of the elements of the loop must be within the operating range (i.e., the valve must not go full open or closed).
8	Record the current value of GAIN (or PB) and measure and record the value of time for one completed oscillation of PV.

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685 834

11.2 Time, Position, or Current Proportional Simplex Control, Continued

Procedure, continued

Table 11-1 Manual Tuning Procedure for Simplex Control, continued

Step	Action
9	Select the proper set of formulas from Table 11-2. Use the values of Gain (or PB) and time (in minutes) in the formulas to arrive at the controller's tuning parameters settings.
10	Enter the values of GAIN (or PB), RATE, and RESET in minutes (or repeats per minute) into the UDC3000 controller and verify that the PV response is adequate. Make additional trimming adjustments, if necessary, to fine tune the controller per the guidelines shown below: TO REDUCE OVERSHOOT Less Gain (more PB) perhaps a longer Rate time. TO INCREASE OVERSHOOT OR INCREASE SPEED OR RESPONSE More Gain (less PB), perhaps shorter Rate time.

Manual tuning formulas

Table 11-2 lists the formulas used in the procedure listed in table 11-1.

Table 11-2 Manual Tuning Formulas

	Units	
	GAIN and RESET TIME in $\frac{\text{Minutes}}{\text{Repeat}}$	% PROPORTIONAL BAND and RESET ACTION in $\frac{\text{Repeats}}{\text{Minutes}}$
Proportional (P) only Use PD+MR Algorithm (i.e. No Reset)	GAIN = Measured Gain x 0.5 RESET TIME = 50.00 (minimum reset) RATE = 0	%PB = Measured PB x 2 RESET ACTION = 0.02 (repeats/minute) RATE = 0
Proportional + Reset (PI) (No Rate)	GAIN = Measured Gain x 0.5 RESET TIME (M/R) = $\frac{\text{Measured Time}}{1.2}$ RATE = 0	%PB = Measured PB x 2.2 RESET ACTION (R/M) = $\frac{1.2}{\text{Measured Time}}$ RATE = 0
Proportional + Reset + Rate (PID)	GAIN = Measured Gain x 0.6 RESET TIME = $\frac{\text{Measured Time}}{2}$ RATE = $\frac{\text{Measured Time}}{8}$	%PB = Measured PB x 1.7 RESET ACTION = $\frac{2}{\text{Measured Time}}$ RATE = $\frac{\text{Measured Time}}{8}$

685 835

11.3 Time Prop rti nal Duplex or Current Proportional Duplex Control

Introduction

For HEAT/COOL applications.
Tune the controller with the output above 50% for Heat and below 50% for Cool.

HEAT/COOL prompts

The "TUNING"\function prompts for HEAT/COOL are:

HEAT	COOL
PB or GAIN	GAIN2
RSETMIN or RSETRPM	RSET2MIN or RSETRPM2
RATEMIN	RATE2MIN
CYCSEC	CYC2SEC

11.4 Two Sets of Tuning Parameters for Single Output Operation

Introduction

You can use two sets of tuning constants for single output types and tune each set separately.

TWO SETS prompts

The "TUNING" function prompts for two sets are:

PID SET 1	PID SET 2
PB or GAIN	GAIN2
RSETMIN or RSETRPM	RSET2MIN or RSETRPM2
RATEMIN	RATE2MIN
CYCSEC	CYC2SEC

Section 12 - App ndix B

How to Apply Digital Instrumentation in Severe Electrical Noise Environments

12.1 Overview

Guideline overview

Products that incorporate digital technology provide recognized performance advantages over conventional analog instrumentation used for process control. These advantages can result in better product uniformity and greater overall efficiency when used correctly.

There are, however, certain guidelines regarding installation and wiring which must be carefully followed in order to achieve this performance. In addition to the traditional precaution of the separation of signal and power wiring in separate conduits, other measures must be taken to minimize the effects of electromagnetic interference (EMI) and radio frequency interference (RFI) on the operation of the equipment. Otherwise, if high level, short duration, noise spikes are permitted to enter the digital equipment, the noise can be transferred into the system's logic networks and can be misinterpreted as signal data, resulting in erroneous system operation and other unpredictable responses.

What's in this section

This section contains the following information:

12.2 Potential Noise Sources

Overview

Noise can enter electronic equipment via three methods of coupling, namely:

- Capacitive (or electrostatic)
- Inductive (or magnetic)
- Impedance.

Capacitive and inductive coupling

Capacitive and inductive coupling have the same essential effect — they couple current or voltage, without any actual connection of the two circuits. Impedance coupling requires a connection between the two circuits. Typical noise-generating sources that could affect electronic equipment through capacitive and inductive coupling include:

- Relay coils
- Solenoids
- AC power wires — particularly at or above 100 Vac
- Current carrying cables
- Thyristor field exciters
- Radio frequency transmissions.

Impedance coupled noise

Impedance-coupled noise may enter by way of the lines used to power the digital equipment or by way of improper grounding. Most power lines, at typical industrial locations, are far from noise-free. The noise on them can be generated in many ways, but are nearly always associated with switching circuits of some nature.

These include:

- Large relays
- Contactors
- Motor starters
- Business and industrial machines
- Power tools
- HID (high intensity discharge) lights
- Silicon controlled rectifiers (SCRs) that are phase-angled fired.

12.3 Prevention Methods

Introduction

There are three ways to prevent electrical noise from interfering with the operation of the electronic digital equipment.

- Built-in noise rejection
- Separation of signal and power lines
- Noise suppression at source

Built-in noise rejection

The first method is to design the digital equipment with a high degree of noise rejection built-in. This includes housing the equipment in a case that will provide shielding, liberal use of noise rejection filters and opto-isolators, and the use of noise suppressors on potential noise sources within the equipment itself. This, of course, is the responsibility of the manufacturer who usually performs extensive laboratory and field testing of newly designed digital equipment to insure the adequacy of its immunity to noise. As a minimum requirement, the equipment should be able to pass the tests outlined in the IEEE Standard 472-1974 *(Surge Withstand Capacity Tests)*.

Signal and power line separation

The second method is to prevent noise from getting on the signal and power lines that are connected to the equipment. This is achieved by proper separation and shielding of those lines. In some cases, separate power lines or special power line regulation or filtering may be required for satisfactory electronic digital equipment operation. It is the responsibility of the installer to follow good wiring practices.

Suppression at the source

The third prevention method is to suppress the noise at its source. This is the most effective but also the most difficult because it is not easy to identify all of the potential noise sources in a typical industrial installation. Therefore, "suppression" is usually a last resort for those extreme situations where the other methods are insufficient by themselves. See *Noise Suppression at Source* which follows.

685 839

12.4 Recommended Wiring Practices

General rules

- All wiring must conform to local codes and practices.
- Wires carrying similar types of signals (Table 12-1) may be bundled together, but bundles with different types of signals must be kept separated to prevent inductive or capacitive coupling.

Wire bundling

Table 12-1 shows what wiring should be bundled together to prevent inductive or capacitive coupling.

Table 12-1 External Wiring

Wire Function		Bundle No.	Are Shielded Twisted Wires Recommended?
No.	**Type**		
	HIGH VOLTAGE	1	NO
1	Line Power		
2	Earth Ground		
3	Line Voltage		
	Digital I/O		
	ANALOG I/O	2	YES
4	Process Variable		
	RTD		
	Thermocouple		
	dc Millivolts		
5	Low level (<100V)		
	4-20 mA dc		
	1-5 Vdc		
	DIGITAL I/O	3	YES
6	Low Voltage (<100V)		
7	Computer Interface		

Continued on next page

12.4 Recommended Wiring Practices, Continued

Additional rules

Please observe these additional rules for wire bundling:

- For distances over five (5) feet, and when shielding is recommended, use a separate metal tray or conduit for each bundle. Where conduits or trays are not practical, use twisted wires with a metal overbraid and provide physical separation of at least one foot.
- Tray covers must be in continuous contact with the side rails of the trays.
- When unlike signal levels must cross, either in trays or conduits, they should cross at a 90-degree angle and at a maximum spacing. Where it is not possible to provide spacing, a grounded steel barrier or grid should be placed between the unlike levels at the crossover points.
- Trays containing low level wiring should have solid bottoms and sides. Tray covers must be used for complete shielding. Tray cover contact with side rails must be positive and continuous to avoid high reluctance air gaps, which impair shielding. Trays for low level cables should be metal and solidly grounded.
- Wires containing low level signals should not be routed near any of the following:
  - Contactors
  - Motors
  - Generators
  - Radio transmitters
  - Wires carrying high current that is being switched on and off.
- Use a 12-gage (or heavier) insulated stranded wire for the ground connection. Attach it firmly to a proven good earth ground such as a metal stake driven into the ground.
- All shields should be grounded at one end only — preferably the instrument end.

12.5 Power Source Considerations

Operate within limits

The AC power for the digital electronic equipment must be within the voltage and frequency limits specified for that equipment. Attempts to operate outside the specified limits will result in no performance. For those installations where the supply voltage will not stay within the specified limits, a ferroresonant transformer, for voltage resolution, should be used.

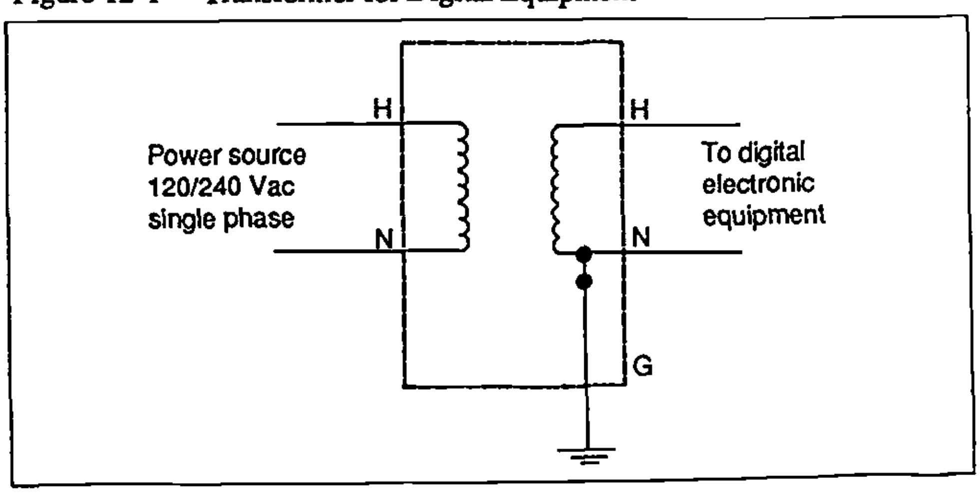
Independent AC source

For protection against noise, the AC source for the digital electronic equipment should be independent of all other loads especially when switching loads are involved. For example, it should not provide power for air-conditioning, convenience outlets, lighting, motors, or similar noise-generating devices. To obtain electrical isolation (see Figure 12-1) a separate transformer is required to supply power to the digital equipment. For additional noise and transient rejection, shielded primary and secondary windings may be required. And, if necessary, power line filters may be added to attenuate noise signals that have a higher frequency than the power line frequency.

Transformer for digital equipment

Figure 12-1 is an illustration of a separate transformer required to supply power to digital equipment.

Figure 12-1 Transformer for Digital Equipment



12.6 Noise Suppression at the Source

Introduction

Generally speaking, when good wiring practices are used with well-designed digital electronic equipment, no further noise protection is necessary. However, in some severe electrical environments, the magnitude of the electrical noise is so great that it must be suppressed at the source. In most control cabinets, the main sources of noise are motor starters, contactors, relays, and switching gear. For this reason, many manufacturers of these devices supply "surge suppressors" which mount directly on the noise source, (for example, on the coil of a control relay or motor starter).

For those devices that do not have accessory "surge suppressors," resistance-capacitance (RC) circuits and/or voltage limiters such as metal varistors may be added when and where needed. This can be broken down into two categories, namely inductive loads (for example, a relay switch in series with a relay coil) and contacts.

Inductive coils

Metal Oxide Varistors (MOVs) are recommended for transient suppression in inductive coils. An MOV is connected in parallel with the coil and is as close as physically possible to the coil (see Figure 12-2). MOV devices (listed in Table 12-2) are recommended for general purpose applications.

Table 12-2 lists part numbers for recommended MOV devices.

Table 12-2 MOV Devices

Part Number	30732481-001 *	30732481-002
Maximum AC	130V	275V
Energy Pulse Rating	10 Joules	15 Joules
Supplier (General Electric)	V130LA10A	V275LA15A

Continued on next page

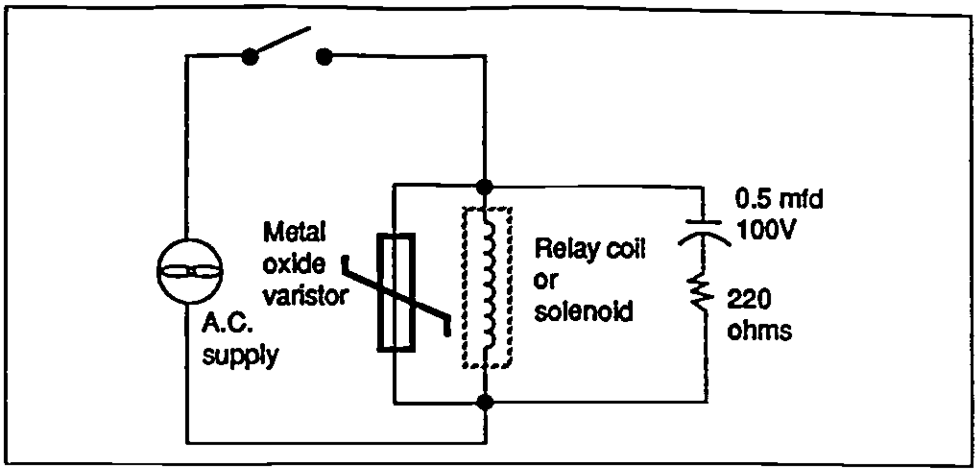
685 843

12.6 Noise Suppression at the Source, Continued

Inductive coils, continued

Figure 12-2 is an illustration of transient suppression in inductive coils.

Figure 12-2 Transient Suppression in Inductive Coils



Additional protection may be provided by adding an RC circuit in parallel with the MOV. This consists of a 220-ohm resistor in series with a 0.5 microfarad, 1000V capacitor. The power rating of the resistor will depend on the voltage rating of the coil (see Table 12-3).

Table 12-3 Coil Voltage vs Resistor Voltage Rating

Coil Voltage	Resistor Voltage Rating
115V	1/4 Watt
230V	1 Watt
460V	3 Watt
550V	5 Watt

Continued on next page

12.6 Noise Suppression at the Source, Continued

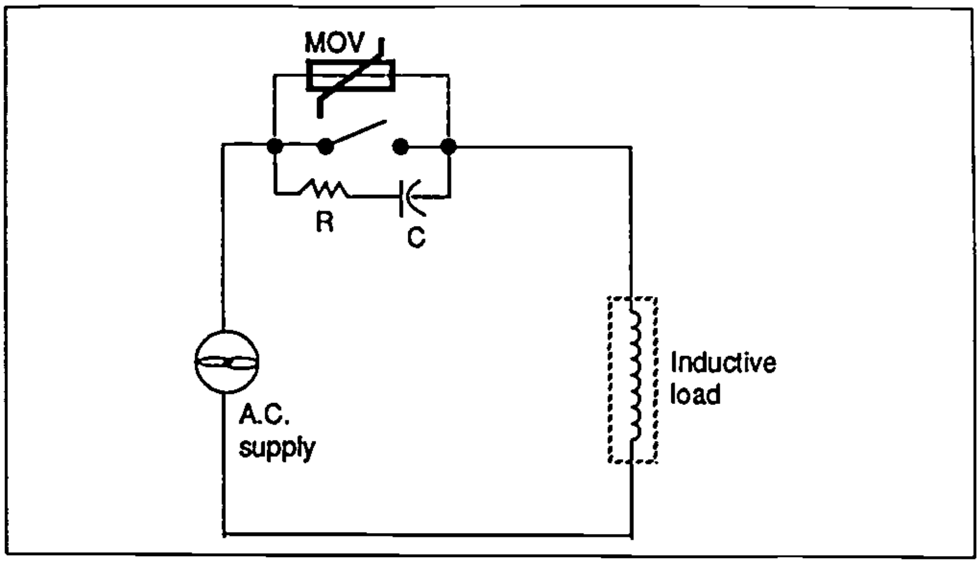
Contacts

When a contact interrupts an inductive load, a certain amount of energy is stored in the load. An MOV or RC circuit in parallel with the load provides a place where this energy may be dissipated. However, if there is no MOV or RC circuit, the energy may create a visible electrical arc across the open contacts. This, in turn, results in electrical noise as well as damage to the contacts.

One way to eliminate this arc is to connect a resistor and capacitor across the contacts (see Figure 12-3). A combination of 47 ohms and 0.1 microfarads (1000 Vdc) is recommended for circuits up to 3 amps and 300 Vac. For voltages above 2000 Vac, an MOV across the contact may be added for extra protection.

Figure 12-3 is an illustration of a resistor and capacitor connected across a contact to eliminate electrical noise.

Figure 12-3 Contact Noise Suppression



For large load currents, a rule of thumb is to size the capacitor so that the number of microfarads equals the number of amperes in the load current, and the resistor has the same resistance value as the load. The objective is to eliminate the visible arc.

Either discreet resistors and capacitors or packaged RC networks may be used. An RC network (47 ohms and 0.1 microfarad) is available from Honeywell as part number 30371852-001. Similar RC networks are available from Electrocube Inc. (part number RG1782-3) and from Industrial Condensor Corporation.

Continued on next page

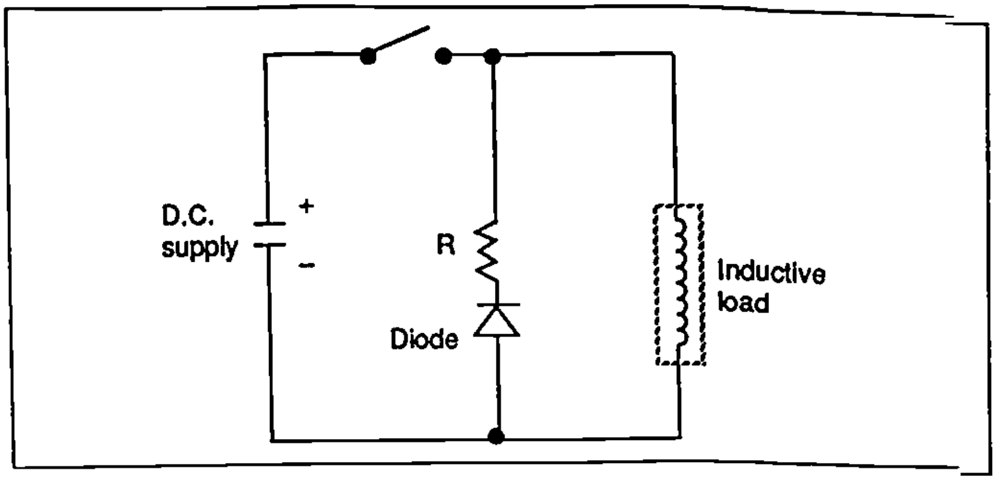
685 845

Contacts, continued

In DC circuits, the power dissipation under steady state condition can be eliminated by placing a diode (in series with a resistor) in parallel with the load (see Figure 12-4). The value of R should be less than or equal to the DC resistance of the inductive load.

Figure 12-4 is an illustration of DC load noise suppression.

Figure 12-4 DC Load Noise Suppression



685 846

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Index

Index

685 849

Index

T

U,V

W,X,Y,Z

685 850

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685 851

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